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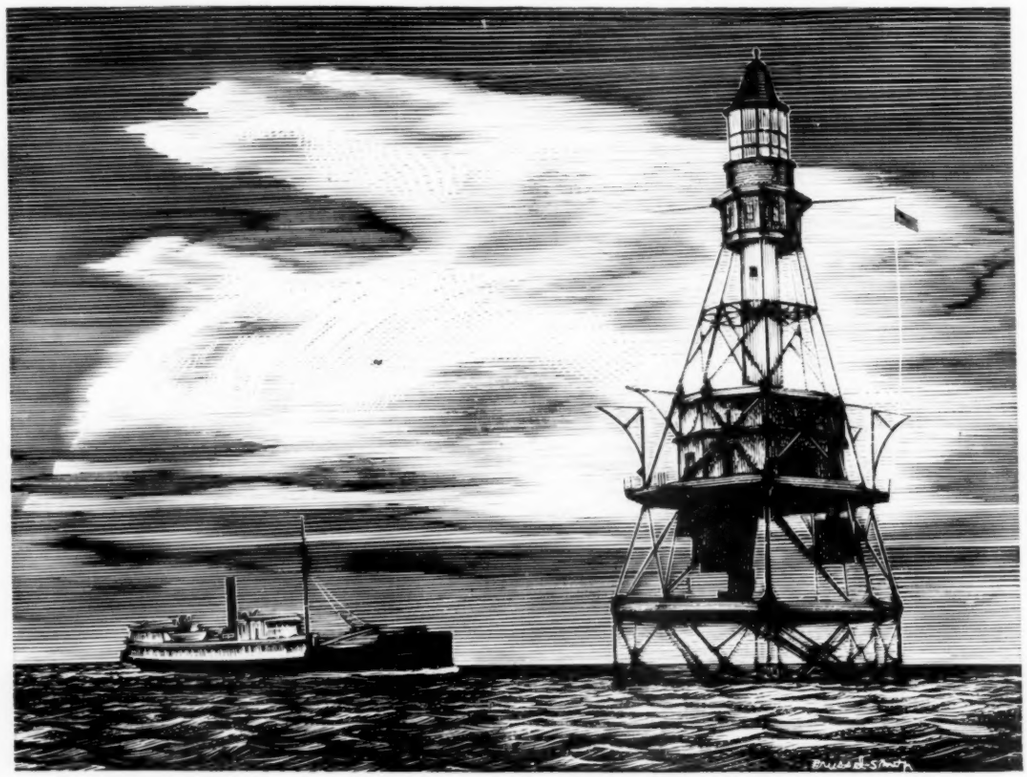

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COVER PHOTO

Army training picture recently made available in color shows a portable flame thrower being demonstrated by members of a Post Chemical School.

The Armed Forces Chemical Journal is the official publication of the Armed Forces Chemical Association. The fact that an article appears in its columns does not indicate the approval of the views expressed in it by any group or any individual other than the author. It is our policy to print articles on subjects of interest in order to stimulate thought and promote discussion; this regardless of the fact that some or all of the opinions advanced may be at variance with those held by the Armed Forces Chemical Association, National Officers, and the Editors.

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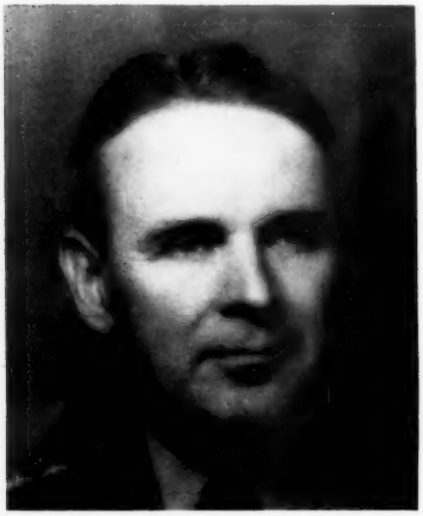
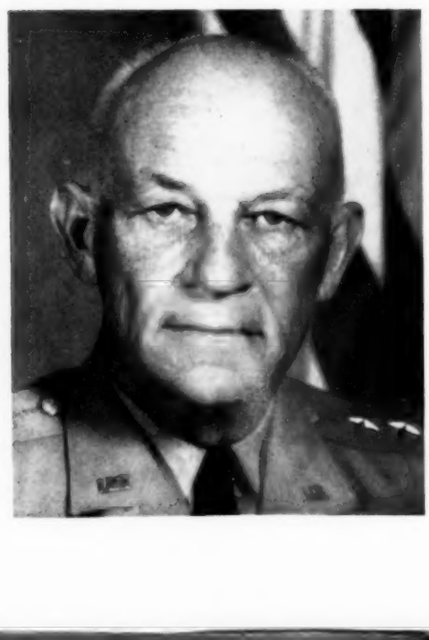


GEN. MAXWELL D. TAYLOR

General Taylor recently assumed duties as Chief of Staff of the Army. His last previous assignment was Commander-in-Chief of both the Far East Command and the United Nations Command, and in that appointment last April he relieved General John E. Hull (see below). General Taylor, native of Keytesville, Mo., commanded the 101st Airborne Division in the Normandy invasion in 1944. He served after the war as Superintendent, U. S. Military Academy and later became the first U. S. Commander in Berlin. In 1953 he took command of the Eighth Army in Korea. In his new assignment as Chief of Staff he has succeeded General Matthew B. Ridgway, now retired.

GEN. MATTHEW B. RIDGWAY

General Ridgway, since his retirement, has been made Chairman of the Board of Trustees of the Mellon Institute of Industrial Research, University of Pittsburgh. Commenting on this assignment, Mr. Richard K. Mellon on behalf of the Trustees of the Institute said: "We are extremely fortunate in securing the services of General Ridgway as Chairman of the Board. His proven ability as a great leader and fine administrator qualify him eminently to assume the chief administrative responsibilities of the Institute . . ."



GEN. JOHN E. HULL

General Hull, who retired last April after 37 years of service, has been elected president of the Manufacturing Chemists' Association, Inc. He served as Vice Chief of Staff of the Army prior to his assignment as Commander-in-Chief of the Far East Command and the United Nations Command. During World War II he was Assistant Chief of Staff for Operations. After the war he served in the Pacific Theater as Commanding General, U. S. Army Forces, Middle Pacific and Commander of Operation SANDSTONE, in charge of testing atomic weapons for the Atomic Energy Commission at Eniwetok in the spring of 1948.

U. S. Army Photo

Boston meeting booster group displaying their message banner at the Cleveland A.F.C.A. meeting last June. Left to right, Mr. A. A. Brown, Mr. Harry A. Wansker, Mr. A. A. Borland, Rear Admiral N. S. Prime, USN (Ret.), Mr. T. D. Adams, and Mr. R. J. Barber.

PLANS TAKE SHAPE FOR A. F. C. A.'s 11th ANNUAL MEETING

A.F.C.A.'s 11TH ANNUAL meeting is still some nine months away, but already a tentative program in considerable detail has taken shape under the enthusiastic guidance of New England Chapter.

The meeting will center in Boston with headquarters at the Hotel Somerset.

The dates, as the plans stand now, are June 14-15, 1956, subject, of course, to approval by the Board of Directors.

The New England group, including Mr. Harry A. Wansker, fifth vice president and chairman of the Meetings Committee of A.F.C.A., hope that members throughout the Nation will start thinking about and planning now on a "pilgrimage" to Boston in the spring of 1956. "Pilgrimage," they feel, is an especially appropriate word for such a visit. For those members who do not know historic New England there is so much of interest to be seen there, even in the short time of a weekend. Lexington, Concord, Bunker Hill, and Old North Church are all virtually just around the corner for anyone in Boston. Plymouth, with its famous Rock where the Pilgrims landed, is but a short distance away. Even quaint old Provincetown on the tip of Cape Cod, where the Pilgrims went ashore before proceeding on across the bay, is within reach during a short stay. But sightseeing for this meeting is, after all, incidental. The program being worked out now provides a well stocked two-day package of both industrial and military interests.

It will be recalled that the Board of Directors at their ninth annual meeting in Washington, D.C. in May 1954 decided upon Boston as the meeting place for 1956.

Ever since then—if indeed not before—New England Chapter has been working on plans for this gathering.

A general A.F.C.A. New England committee of 22

Hotel Somerset—Gardens

members has been appointed, and from this group subcommittees as required for the various special tasks involved in arranging for the annual meeting will be selected. Mr. Wansker, who has a twofold interest in this meeting because he is national Meetings Committee chairman and also a member of the New England Chapter, is general chairman of this local committee.

The program, subject of course to changes and readjustments as circumstances may dictate, stands as follows at this writing:

FIRST DAY—June 14, 1956 (Flag Day)

Registration—Hotel Somerset

Massachusetts Institute of Technology (Cambridge)—Tour of the Institute's classrooms, laboratories and shops followed by a short discussion period in the auditorium dealing with the part chemistry plays in the activities and plans of the Armed Forces.

Acorn Park—Luncheon and tour of the Arthur D. Little, Inc., establishment.

Babson Park—Tour of the Babson Institute of Business Administration with a discussion period on the "meaning of a military career now and in the future" as the topic.

Directors Meeting—To be held in the Richard Knight auditorium following a catered supper to be served at Babson Park at 5:30 P.M.

Alternate Programs—A list of other establishments, both commercial and government, which would provide interesting visits has been prepared for alternate plans.

SECOND DAY—June 15, 1956

Armed Forces Installations—It is planned that the second day's program, including the afternoon speeches, would be carried out at an appropriate military or naval installation as may be arranged. Some specific proposals in this connection have been considered in detail. However, the Committee does not wish to make any announcement on this at this time. It is expected that this phase of the program will be firmed up in time for a definite announcement in the next issue of the Journal.

Reception and Banquet—Hotel Somerset.

LADIES' PROGRAM—June 14

Several alternate plans for the special program for the ladies have been worked out. One of these which is highly favored is for the group to proceed by chartered buses to Rindge, N.H., for a guided tour of the Cathedral of the Pines under the direction of Mr. Douglas Sloane, the founder of that noted war memorial. Under this plan the group would then proceed by bus to the Groton Inn or some other nearby restaurant for luncheon. In the afternoon they would first visit the museum at Harvard to see the famous exhibition of glass flowers there. Following this they would go to Babson Park for the afternoon and supper program there as arranged for the men.

The Boston meeting committee consists of the following:

Richard G. Woodbury, American Optical Company, Southbridge, Massachusetts

Commander Eric C. Purdon, USN, Headquarters First Naval District, Boston, Massachusetts

Lt. Commander J. H. Kerrell, USN, Public Information Officer, Naval Air Station, Quonset Point, R.I.

Edward J. Bushell, Attorney-at-Law, 6 Pleasant Street, Malden, Massachusetts

James Donovan, Artisan Metal Products, Inc., 73 Pond St., Waltham, Massachusetts

John J. McDonald, The Brown Company, 3 Overlook Way, Winchester, Massachusetts

Charles B. Weeks, Hesse-Eastern Division of Flightex Fabrics, Inc., 136 Mt. Auburn Street, Cambridge, Massachusetts

Dr. Harold C. Weber, Massachusetts Institute of Technology, Cambridge, Massachusetts

Earl Watson, 53 State Street, Room 909, Boston, Massachusetts

William Tracy, International Silver Co., Factory A, Wallingford, Connecticut

Matthew M. Berman, L. E. Mason Co., 98 Business Street, Hyde Park, Massachusetts

Dr. E. B. Hinckley, President, Babson Institute of Business Administration, Wellesley, Massachusetts

Brig. Gen. James F. McManmon, USAFR, Chairman of the Board, Harrington & Richardson Co., Worchester, Massachusetts

Whitfield Reid, Counsellor-at-Law, 85 Devonshire Street, Boston, Massachusetts

Sinclair Weeks, Jr., United-Carr Fastener Corporation, 31 Ames Street, Cambridge, Massachusetts

Albert A. Brown, B. C. Morton & Co., 131 State Street, Boston, Massachusetts

H. A. Wansker, United-Carr Fastener Corporation, 31 Ames Street, Cambridge, Massachusetts

Chenery Salmon, Merchants National Bank, 28 State Street, Boston, Massachusetts

John H. Adams, Arthur D. Little, Inc., 30 Memorial Drive, Cambridge, Massachusetts

Frank L. Armitage, Firestone Ind. Products Co., Fall River, Massachusetts

Arthur G. Boardman, Mutual Benefit Life Insurance Co., 40 Central Street, Boston, Massachusetts

A. A. Borland, National Fireworks Ordnance Corp., West Hanover, Massachusetts

Assignments so far for specific duties are:

General Chairman, annual meeting—H. A. Wansker; Deputy Chairman, annual meeting—Brig. Gen. F. J. McManmon; Secretary—John Adams; Financial Chairman—Chenery Salmon; Plant Visit Chairman—Albert A. Brown; MIT Visit Chairman—Dr. Harold Weber; Babson Visit Chairman—Dr. Edward Hinckley; First Naval District Navy Liaison—Cdr. Purdon; Quonset Point Navy Liaison—Lt. Cdr. Kerrell; Publicity Chairman—Whitfield Reid; Tour Chairman—Richard G. Woodbury.

Swimming Pool—Hotel Somerset

A. F. C. A. MEETINGS THROUGH THE YEARS

This being the tenth year since the organization of A.F.C.A. it seems appropriate to provide a resume of previous annual meetings. Such a review, based upon reports of these meetings contained in past issues of the ARMED FORCES CHEMICAL JOURNAL, is presented here.

1946: First Meeting at Edgewood Arsenal; Col. Herbert K. Bear, the "Keynoter"; Col. Ludlow King Elected President.

THE FIRST ANNUAL meeting of the Association was held at Edgewood Arsenal, Maryland, May 24-25, 1946. Number 1 of Volume I of the JOURNAL, the first issue of the magazine which came out in October 1946, tells of the organization of the Association, commencing with the preliminary steps taken in the latter part of 1945 and the subsequent actions which brought the Association definitely into being early in 1946 guided by a provisional executive committee, headed by Colonel Herbert K. Bear as president. Under the enthusiastic leadership of Colonel Bear and his associates the Association grew to sizable proportions well before the first annual meeting was held. Thus, despite the railroad strike at the time which the JOURNAL account refers to, 512 members assembled at Edgewood Arsenal for this first gathering on May 24. The constitution had been written and adopted. Sixteen chapters throughout the country had already been established and a distinguished group had been elected Directors-at-Large.

Colonel Bear, in his address to the meeting as the first provisional president, emphasized the character of the Association. He pointed out that it was not essentially an organization of reserve officers nor of veterans but one which was open to all patriotic men and women, officers, enlisted personnel, and civilians interested particularly in the role of the Chemical Corps (then the Chemical Warfare Service) in the national defense program. Colonel Ludlow King, then Washington manager of the Owens-Corning Fiberglas Corporation, was elected president at this first meeting held under the provisions of the newly adopted constitution. His remarks in accepting the position were significant. He pointed out that the Association would not limit its endeavors to the Chemical Warfare Service; that it was interested in the entire Army and in promoting a strong National Defense. It may be interesting to note at this point that both the name of the Association and that of the place where this first annual meeting was held subsequently were changed. The Association, originally called the Chemical Warfare Association, later became the Chemical Corps Association and still later, in conformity with the new concepts of integration of the Services in a Department of Defense, the name was changed to the Armed Forces Chemical Association. Meanwhile, the name Edgewood Arsenal, which long had stood for the principal field establishment of the Chemical Warfare Service, was changed to Army Chemical Center. The name Edgewood Arsenal is still used but is applied now only to the arsenal establishment at the Center which has other important activities.

Captain Joseph Schwimer, the first secretary-treasurer, in his account of the meeting given in the first issue of the JOURNAL, refers to the salutory address to the Association made by General J. Lawton Collins, the Chief of Information in the War Department who later became Chief of Staff, and to the remarks of welcome by Maj. Gen. Alden H. Waitt, then Chief of the Chemical Corps. Other speakers reported were Brig. Gen. Charles E. Loucks, who then headed the Corps' Research and Development activities; Major W. D. Kavanaugh, Dr. W. A. Noyes, Jr. (his address was read, since he was unable to attend), and two industrialists. These were Mr. W. E. Ferris, vice-president of The Day and Night Manufacturing Company, Monrovia, California, and Mr. W. W. Finlay, president of The Guiberson Manufacturing Company, Dallas, Texas. Thus, at its very start one of the essential purposes of the Association, namely, the promotion of close linkage and friendly relations between the military and industry, was recognized and given appropriate emphasis.

1947: Ludlow King Re-elected; Harry Kuhn, 1st Vice President; Under Secy. Royall, the Speaker.

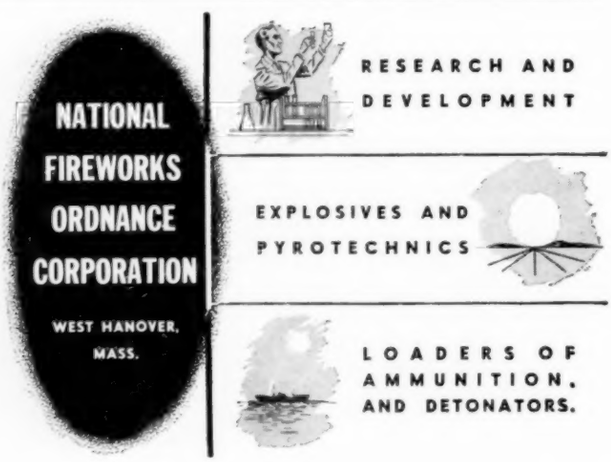
THE APRIL ISSUE of the then quarterly JOURNAL heralded the second annual meeting which was also held at Edgewood Arsenal, the dates being May 23-24. It is noteworthy that this issue of the magazine contained a printed ballot for election of Directors-at-Large with instructions for it to be torn out and mailed to the Association's headquarters after being filled in by the voter. That issue also contained a directory of the Association's membership as part of the magazine. The meeting and speeches were reported in the July issue. Colonel Ludlow King was re-elected and Colonel Harry A. Kuhn (ret.) was made first vice president. Among the guest speakers for this meeting were The Hon. Kenneth C. Royall, Under Secretary of the Army, and Mr. Harry L. Derby representing industry. Particularly noteworthy about this meeting was the exhibit of chemical equipment and a visit to the chlorine plant at the Arsenal through the courtesy of the Diamond Alkali Company which operated the plant. It was estimated that some 700 members attended this meetings.

1948: Important Constitutional Changes; Name Changed to A.F.C.A.; Kuhn is Elected President; General Devers is Speaker.

THE THIRD ANNUAL meeting, like the previous ones, was held at the Army Chemical Center, Md. (Edgewood). The dates were May 20-22, 1948. The meeting resulted in a number of important actions bearing upon the development and growth of the Association. In line with the armed services integration program and the establishment of the Department of Defense, the Association's name was changed to the Armed Forces Chemical Association by action of the directors. A new class of membership known as "sustaining members" was defined and established. The position of Immediate Past President of the Association was recognized and included in the voting membership of the executive committee and, among other actions, the directors at this meeting adopted an amendment to the constitution of the Association requiring chapters to hold at least two meetings each year. Colonel Harry A. Kuhn (ret.) was elected president and Dr. Walter E. Lawson was made first vice-president. General Jacob L. Devers, then Chief of the Army Field Forces, was the principal banquet guest. In his address he spoke highly of the work of the Chemical Warfare Service during the war. During this year Mr. Fred Jacobs, who had retired from his position in the Office of the Chief Chemical Officer, was named secretary-treasurer of the Association, enabling Captain Schwimer thereafter to devote full time to his work as advertising manager. These interim changes were noted and approved at the annual meeting.

1949: Chairman of Munitions Board Speaks; Chemical and Air Demonstrations; ROTC Award Program Inaugurated.

IN REPORTING the fourth annual meeting of the Association, which was held at the Army Chemical Center on the dates May 19-21, the JOURNAL (July 1949 issue) referred to it as the "best yet." The account reads in part, "Amid a spirit of unification that may easily set a pattern for the professional services, the Armed Forces Chemical Association at its fourth annual meeting at the Army Chemical Center (May 19-21) combined the talents and interest of Army, Navy and Air Force departments and recorded for historical purposes a 'best yet' convention." The principal speaker at the banquet, at which President Kuhn presided, was Mr. Donald F. Carpenter, then Chairman of the Munitions Board. He spoke on "Industrial Mobilization." It was at this meeting that exception was taken to the practice of the Association in holding all of its annual meetings at the Army Chemical Center. Fifth Vice-President Roy D. Kulp urged a policy of variety in the selection of places for annual meetings so as to broaden the scope of their appeal and availability to the membership. It was at this meeting also that Dr. Walter E. Lawson of the Du Pont Company reported on the program for medal awards to outstanding ROTC students majoring in chemical subjects and received the approval of the program he had developed. Colonel Kuhn was re-elected president and the Chief Chemical Officer, General Waitt, was designated honorary president.



1950: Meeting at Virginia Beach; Visit to Norfolk Naval Base; Message from Gen. McAuliffe; Dr. Lawson New President.

IN LINE WITH the idea of variety in meeting places, the fifth annual gathering of the Association was held at Virginia Beach where headquarters for the meeting were established at the Cavalier Hotel. Major General Anthony C. McAuliffe, then the Chief Chemical Officer, was unable to attend himself, but sent a prepared address to the Association expressing his appreciation of its assistance to the Chemical Corps and asking for its continued collaboration and support. The meeting, notable especially for its Navy sponsorship, included a visit by the attending members to the nearby Norfolk Naval Base. In this connection, the July 1950 JOURNAL states, "In addition to inspection of ships, members attending witnessed the famed fire-fighting procedures and practices of the Fifth Naval District Structural Fire-Fighting School." Dr. Walter E. Lawson at this meeting was elected president and Colonel Louis W. Munchmeyer of the General Aniline & Film Corporation was made first vice-president.

1951: Gathering at Atlantic City; Gen. McAuliffe, Mr. Geo. Merck, Gen. Maas and Gen. Edwards Speak; Dr. Lawson Re-elected.

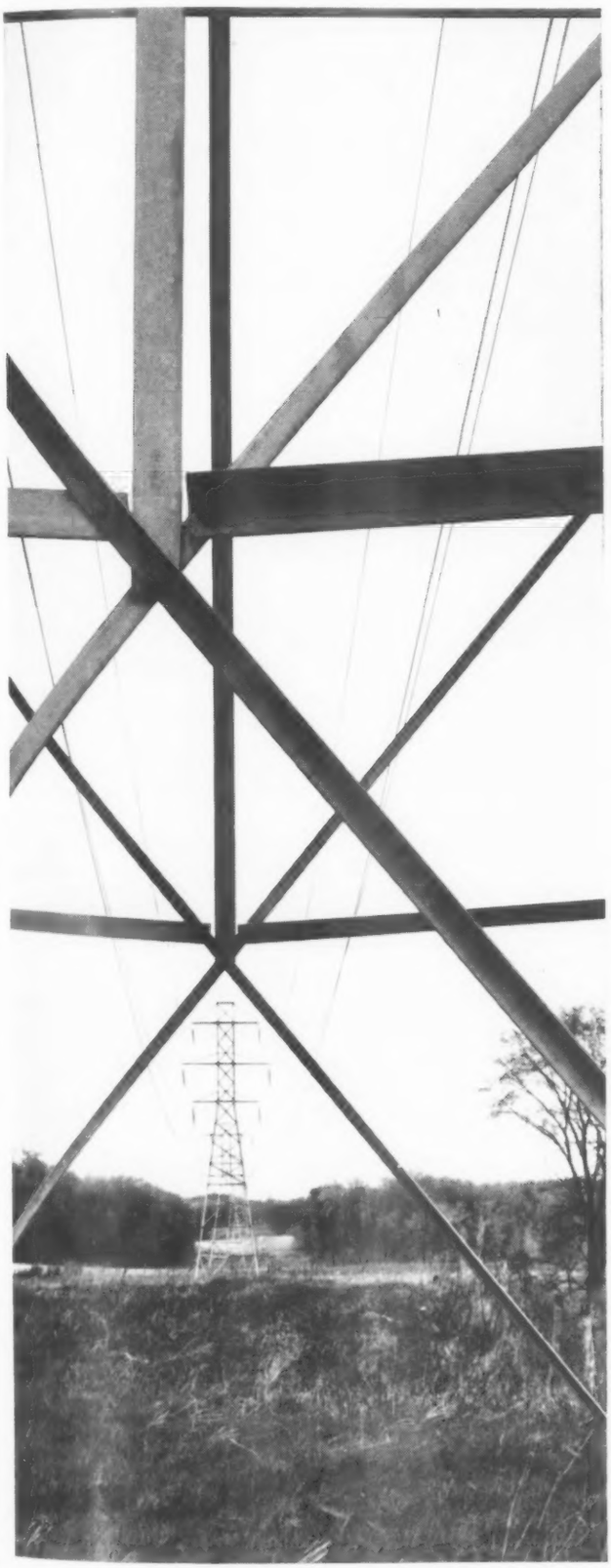
A SERIES OF outstanding speeches marked the sixth annual meeting of the Association at the Claridge Hotel in Atlantic City on May 10-11 with Dr. Walter E. Lawson presiding. At the afternoon session on May 11 the speakers were Maj. Gen. Anthony C. McAuliffe, Chief Chemical Officer, who told of the functions and activities of the Chemical Corps in a speech entitled "Brother Service." Mr. George W. Merck, Chairman of the Board of Merck & Company, in his speech on "Chemical Mobilization," dealt particularly with problems which confronted the chemical industry following World War II, including consideration of the Korean situation. Another outstanding talk was that of General Melvin J. Maas, USMC (ret.), who urged the provision of an adequate reserve establishment. His topic was "The Reserve Officer." Lt. Gen. Idwal H. Edwards, U. S. Air Force, gave the principal address at the annual banquet, a timely review of "The Military Situation." The Board of Directors re-elected Dr. Lawson president and Colonel Louis W. Munchmeyer first vice president.

1952: Midwest is Host in Chicago; Secretary of Navy, Speaker at Banquet; Program for Ladies Provided.

THE HOTEL SHERMAN in Chicago was the scene of the seventh annual meeting of the Association on May 15-17, 1952, with the Midwest Chapter in the role of host. Colonel Louis W. Munchmeyer was elected president and

(Continued on page 30)

from a maintenance point of view . . .



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ENGINEERING MILITARY MATERIEL *for* ECONOMICAL MASS PRODUCIBILITY

By WILLIAM E. GROSS

Chief, Protective Branch, Products Division
Chemical Corps Engineering Agency
Army Chemical Center, Maryland

(A penny saved in manufacturing a single item means $10,000 saved when the order is for a million, and a minute of labor per item saved in such an order means an over-all time saving of eight man-years. These and other interesting facts pertaining to production economy are presented by Mr. Gross in this article, which is the second of a series dealing with the functions and operations of the Chemical Corps Engineering Agency. The first article, written by Colonel William J. Allen, Jr., commanding officer of the Agency, was published in the March-April issue of the JOURNAL.—ED.)

Importance

IN TIME OF WAR three elements of the national economy are at a premium—trained manpower, the instruments of production, and natural resources. In the last two wars, due to the pressure of necessity resulting from inadequate military preparedness, the United States was forced into uneconomical utilization of all three elements. The importance of maximum conservation of these elements is becoming increasingly apparent, emphasized by the large reserves of manpower and natural resources available to the potential aggressor nations. It is further obvious that any waste represents dollar loss. Failure to conserve these resources could result in the inability of our country to meet the armed competition of a belligerent nation. The need to engineer military materiel for economical mass production and minimum use of skilled manpower and critical materials is vital to the national safety.

Much military equipment must inherently be complicated in structure and employ critical materials. However, close examination of most developmental items generally reveals that those which are inherently complex, as well as those which are inherently simple, are basically capable of simplification without functional impairment. Further, it will often be found that noncritical materials can be substituted for critical. Modification of item designs to improve producibility also often results in functional improvement. In the design of military equipment the primary object is to provide the desired military characteristics, because that materiel which does not meet functional requirements is obviously the most uneconomical of all. The item should be developed so that it is finally resolved to its most simple form from the standpoints of both operation and production.

To emphasize the importance of engineering for mass-producibility to reduce the unit cost of items manufactured in large quantities, the author will refer to an item developed and manufactured during the last large-scale production of military items, World War II; namely, the M10A1 gas mask canister. The M10A1 canister, costing $1.55, is essentially a redesign of canister M9A2, which cost $2.50—a saving of $0.95 per item. Twenty million M10A1 canisters were manufactured during World War II—saving the taxpayers the tidy sum of nineteen million dollars. (Above figures are in World War II currency. The figures would be considerably higher based on present value of the dollar.)

In addition to this money saving is the assistance given the war effort by freeing portions of the above-discussed three elements for other uses. The redesign facilitated an increased rate of canister production, resulting in supplying the necessary quantity of canisters to protect our troops much more rapidly than would have been possible with the older model. This is an example of how designing for economical mass-producibility saves valuable time. The two canisters are shown in Figure 1.

Figure 1

M9A2 M10A1

Without going into details of the redesign, it can be stated that the above-mentioned savings were made possible to a minor extent by the availability of improved gas and aerosol filtering materials, which permitted a reduction in size. However, the real savings were effected

by application of sound engineering principles such as: eliminating soldering; designing to fasten parts by pressing, crimping, and beading; changing from an essentially oval to a round cross-section, thus greatly simplifying die construction; substituting die-formed parts for machined parts; designing a number of components to be made on standard sanitary-can-making machinery; changing the method of securing the finer filter from the use of pressure sensitive adhesive tape to pinching it between the newly designed breathing tube and baffle cups; designing improved equipment (1, 2, 3, 4, 5)[1] for assembling the canister to reduce rejects, etc. This canister is used on the standard optical gas mask M2-10A1-6, the tank mask M14, and also the lightweight service masks M3, M3A1, M4, and M4A1 now limited standard. It is covered by U. S. Patent No. 2,406,368, granted to the author.

Following World War II, principally because of the increased specialization or complexity in manufacturing methods and processes, the Chemical Corps encountered considerable difficulty in transition of development prototypes to current industrial production. This condition forcefully pointed out the need to engineer developmental items for economical mass-producibility, and primarily for this mission the Chemical Corps Engineering Agency was organized and established in May 1951.

Accomplishment of Economical Mass-Producibility

Prior to initiating development work on a Chemical Corps end item, its military requirement, project, and functional characteristics, respectively, are established with the concurrence of representatives of other Department of Defense agencies, via Chemical Corps Technical Committee action. To ensure economical mass-producibility of the item under development, the Chemical Corps Research and Engineering Command (RECOM) procedure is arranged so that the Chemical Corps Engineering Agency (CCEA) project engineer works closely with the Chemical Corps Chemical and Radiological Laboratories (C&RL) development project engineer. This close liaison is maintained from the prototype preparation stage forward so that the CCEA project engineer can guide design of the item toward the optimum from a mass-producibility standpoint.

Mass-producibility of an item is accomplished essentially by a continuing engineering evaluation of the item as the design changes through development, to ensure that the functional design changes also meet mass-producibility criteria. The method of conducting this engineering evaluation is applicable to both standard (already developed items in production) and experimental items, and is discussed in greater detail later in this paper. Improvements to enhance mass-producibility are suggested to the development engineer as indicated. The very important purpose of this method of operation is to ensure, by the joint effort of the development and product design (CCEA project) engineers, that items are satisfactory from both functional and mass-producibility criteria before final laboratory testing is initiated. This extremely important objective is to eliminate the possibility of having to re-develop the item for mass-producibility, either prior to or after it is placed in production.

The most important aspect of this procedure is that it saves valuable time in transition from prototype to production model. Obviously, in time of or in preparation for a defensive war, speed of transition from prototype to production is critical to the national safety. Another extremely important result is a saving in money for the taxpayers.

Prior to procurement of a developed item for final laboratory testing, it is reviewed by a board of engineering specialists, designated the Design Review Board, at the Chemical Corps Engineering Agency to ensure that all difficulties relative to mass-producibility have been anticipated and corrected. The Design Review Board consists of the following CCEA personnel; chief engineer, chairman; project engineer for the specific item under review; packaging engineer; standardization engineer; design engineer; maintenance engineer; quality control engineer; and a human engineer. The C&RL development engineer for the specific item under review; and the Chemical Corps Material Command (MATCOM) associate project engineer representing industrial, quality control, and supply engineers of that Command, attend the review board meetings in an advisory capacity. Review by the board is intended to ensure that the item is satisfactory from a mass-producibility standpoint and that standardization of components has been accomplished before it is submitted to final laboratory testing.

After the item has satisfactorily passed the final laboratory tests it is transferred to the Engineering Agency for finalization. Based on information and guidance supplied by the project engineer who has complete responsibility for the item, Engineering Agency facilities then prepare specifications, drawings, operating directives, and technical manuals for forwarding to MATCOM for scheduling of user test procurement. User test procurement is the means by which an item is proved mass-producible—a "shake-down" of the item from a mass-producibility standpoint. A user test procurement committee is formed,

[1] Numbers in parenthesis refer to bibliography at end of paper.

WILLIAM E. GROSS

Mr. William E. Gross has served twenty-six years as a development and production engineer with the Chemical Corps. Twenty-three years of this service were spent in the Protective Division, Chemical and Radiological Laboratories. Mr. Gross has been granted eight patents for protective devices, and for machinery and testing equipment used in their manufacture. Commercial rights to several of these patents have been licensed for use by industrial concerns.

Mr. Gross was awarded the Gold Medal by the War Department for exceptional civilian service during World War II. He has written many reports covering his technical activities, including papers published by the "American Society for Testing Materials Bulletin" and "Mechanical Engineering."

In March 1952 he was transferred to the Chemical Corps Engineering Agency, where he now serves as Chief, Protective Branch.

consisting of one member each from Inspection Division and Industrial Division, MATCOM; and RECOM (normally from the Engineering Agency). The purpose of this committee is to monitor and make necessary changes to the item during its manufacture to ensure its future mass-producibility. The members provide essential background in the fields of inspection and procurement, and in the technical aspects.

If the item is shown to be satisfactory from a mass-producibility standpoint, the committee so indicates in an interim final log report. (Chronological log reports and historical records are prepared covering the committee's activities.) The RECOM member then recommends to Headquarters RECOM that tests, commonly referred to as "user tests," be initiated by the using service or services. On satisfactory completion of these tests, RECOM recommends the item for standardization.

If standardized, the item is listed in the Chemical Corps Book of Standards, which is essentially a catalog indicating that this item is available in the supply system and subject to purchase by the various using services: Army, Navy, Air Force, or Marine Corps.

Engineering Evaluation of Experimental and Standard Materiel

To achieve economical mass-producibility, an engineering evaluation involving all fields of engineering science is conducted to determine whether each component, subassembly, and assembly is properly designed to ensure maximum accomplishment of the following discussed objectives without abridgment of functional (military) characteristics. In brief, the objective is to cut cost, speed production, and maintain quality.

Mass-Producibility.—Mass-producibility is achieved largely by design of item to ensure maximum applicability to manufacture by conventional methods or processes on standard machinery from readily available and economic materials, and with the maximum of automatization. This phase of the evaluation necessarily involves considerable contact with industry and requires close following of pertinent technical journals and textbooks to keep abreast of advances in industrial arts.

Elimination of Critical Materials.—Elimination of critical materials is accomplished generally by substitution of noncritical materials where possible and practical from a manufacturing standpoint. However, if a critical material or a critical alloying element must be used, the least critical practical material is chosen. This selection is in accordance with the relative scarcity number system delineated by the Department of Defense Materials Conservation List of materials determined as potentially scarce under conditions of mobilization.

Minimizing Labor Requirements, Especially Skilled Labor.—Minimizing labor requirements is essential for military items which must be produced in time of national emergency when manpower must be carefully conserved. Labor savings are accomplished largely by use of maximum tolerances; design for manufacture by automatic and semi-automatic processes; substitution of weldments, die casting, or die forming for machine tool methods; use of roughest finishes practical; and design of components to permit assembly without, or with a minimum of, measuring or accurate alignment.

Utilization of Standard Components.— This phase involves design, insofar as practical, for utilization of commercially available or military standard components, modified if necessary to meet functional requirements.

Human Engineering.—Human engineering principles are incorporated into designs because of the essential need to integrate materiel and operator into an efficient and smoothly running system. The optimum in efficacy of man-machine operation is achieved only when the capabilities and limitations of the operators thereof are recognized, carefully considered, and incorporated by the designer.

Packaging.—Because size, weight, and protection of materiel is of great importance to logistics, extremely careful consideration is given to the packaging aspect of materiel designs. Such considerations involve possibility of: reducing weight, cubage, and fragility; providing mounting lugs inboard; arranging fragile components to be placed within the less-fragile components or the end item itself, or separating fragile components from heavy items; and increasing strength of items to improve shipping and handling characteristics. Items intended for front line combat areas are, insofar as practical, designed to be transportable by one man; thus eliminating dependency on mechanical handling equipment. In the case of heavy equipment, due consideration is given to the fact that size and weight are limited in that the item must be capable of movement over rail and highway systems likely to be encountered in theaters of operation. The packing materials employed must be of the most economic standard materials available and capable of fabrication by standard methods and machines with the maximum degree of automation possible. It should be pointed out that the numerous details involved in packaging military materiel (types of crates, waterproofing, tiedown methods, etc.) require a relatively exact technology, supervised by an expert packaging engineer.

Surveillance.—Information derived from periodic inspection of materiel in storage or in use (field surveillance) is pertinent to indicated improvement of standard items and avoidance of weaknesses in developmental items. It is also incumbent on the project engineer to establish sound technical criteria for surveillance. In large part, surveillance data for similar previous designs also guide the realistic provision for repair parts in the supply system.

Coordination.—Consultations are held with development laboratory (C&RL); liaison representatives of other Department of the Army technical services, the Air Force, the Department of the Navy, and others; Inspection, Industrial, and Supply Divisions of MATCOM; industrial organizations; and other personnel having competency in the field involved. This coordination ensures that materiel designs incorporate all pertinent data relative to functioning, cost, and producibility.

Examples of Savings Achieved by Engineering for Economical Mass-Producibility

As previously discussed, the CCEA project (product design) engineer works in close cooperation with the development engineer to achieve the maximum in mass-producibility before the item is subjected to final laboratory tests for proof of functioning. Thus very little opportunity exists to demonstrate the cost saving accomplished by the CCEA project engineer. Therefore, selected as examples are items which, prior to the establishment of the Engineering Agency or due to an urgent need for an item such as the M1 waterproofing bag, were either standardized and then placed into production or were placed into production directly from the development laboratory and then standardized. In other words the examples cited are items placed into production without an opportunity for the project engineers to make them economically mass-producible.

In the following discussed examples little physical

change can be seen between the originals and the redesigns. For this reason, except for the M173A1 fuze, only the redesigned items are shown in the illustrations.

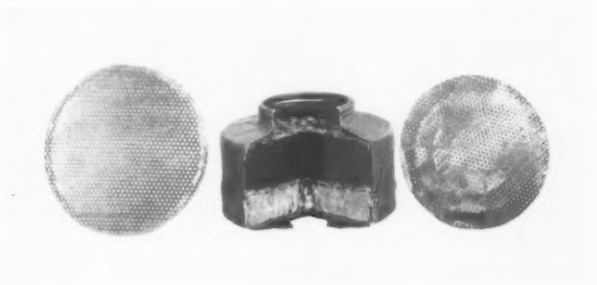

Figure 2
Canister, M11

This item as developed during World War II was limited to the use of wood-base charcoal, a special material. When manufacture of this canister was started during the Korean incident, Chemical Corps facilities for the manufacture of wood-base charcoal were in a standby status and not in condition to be made immediately available for production. To put the facilities into a producing condition, which would also have involved expansion to meet volume requirements, would have resulted in a considerable delay in starting manufacture of the canister.

The author made a design study of the item, which indicated that without change to existing canister tools and assembly machinery the incorporation of the two 10 mil thick perforated aluminum reinforcing discs shown in Figure 2 would permit use of commercially available coal-base charcoal. This design change was proved (6) and incorporated.

No details of actual savings are presented here; however, the design change eliminated the necessity for the Chemical Corps to put into operating condition and expand the special facilities to manufacture wood-base charcoal—at a considerable expense. In addition to that saving is the saving resulting from the use of coal-base charcoal, which is somewhat less expensive than wood-base.

Further, the change permitted the immediate manufacture of the M9A1 gas mask which otherwise would

Figure 3
Bag, Waterproofing, M1

Cost per unit before redesign (estimated*)	69c
Cost per unit after redesign	31c
Saving per unit accomplished by redesign	38c

*The actual per unit cost to the government before redesign was lower than the figure shown, due to underestimating by the contractor which resulted in a monetary loss to him. As a result of his experience he stated that on any additional contract he would have to charge a minimum of approximately 68c to 70c.

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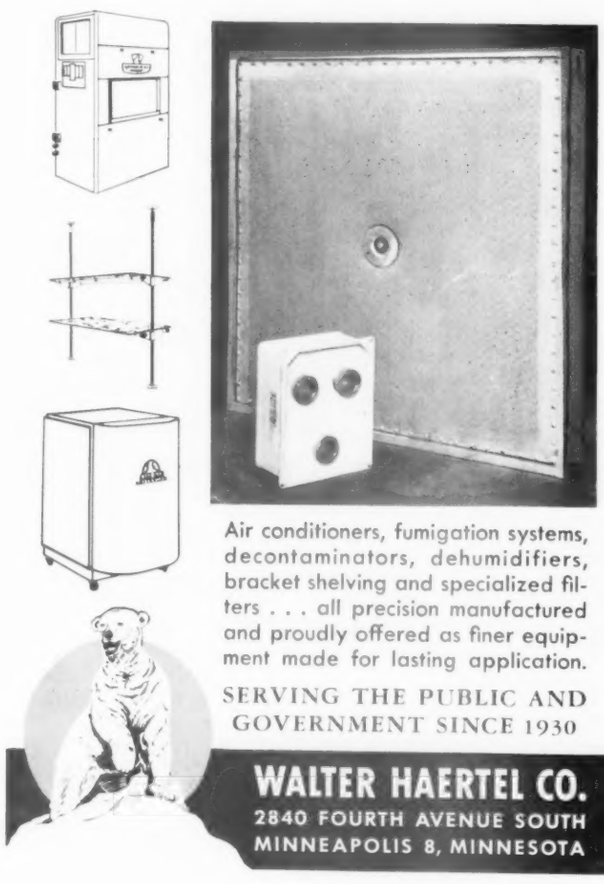

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have been delayed for a considerable period. The functioning of the M11 canister was also slightly improved by the use of the coal-base charcoal, which generally exhibits improved storage characteristics.

Based on procurement over the last several years at an approximate saving of 38c per bag, a total saving of $266,000 has already been realized for the government.

The waterproofing bag M1 was designed to permit waterproofing of the M9A1 field protective mask during amphibious operations. Due to an urgent need by the Marine Corps, time did not permit engineering this item for economical mass-producibility and it was placed in production directly from the development laboratory.

The changes resulting in the reduced cost were achieved principally by the selection and substitution of lower priced, more readily available material covered by a government specification, which was also less difficult to fabricate. The original material was special and expensive, extremely difficult to fabricate, and resulted in an exorbitant rejection rate. The changes also resulted in considerable functional improvement consisting essentially of greatly strengthened seams, elimination of the tendency to dissolve finishes (varnish, paint, etc.) on which the bag was placed, and improved storage characteristics especially at high temperatures. Further, the redesign eliminated the adverse psychological effect caused by exudation of the plasticizer which caused the original bag to have a wet or slipperly surface, smearing the gas mask lenses and under certain conditions emitting an offensive odor.

A further result of the engineering is the greatly improved appearance. The material in the original bag presented a dull, brown, dirty appearance; the material in the redesigned bag is clear and clean.

Figure 4
M116A1 Fire Bomb Attached to an Aircraft

Bomb, Fire, 750-lb., M116A1

Cost before redesign .....$	103.00
Cost after redesign	83.00
Estimated saving per million units	20,000,000.00

Since approximately 150,000 of the redesigned items are currently in procurement, a saving of approximately $3,000,000 is presently being realized.

The fire bomb is designed for delivery on target, ignition, and dispersion of thickened gasoline serving as an incendiary agent for anti-personnel and anti-tank operations. The frangible bomb is released at low altitudes and is ruptured on target impact, thus spreading the contents. The contents are ignited by white phosphorus dispersed from igniters, designated M23A1, which are mounted one each on the fore and aft ends of the bomb. The igniters are fragmented by the M173A1 fuze, described later in this article.

The savings were effected principally by reengineering the bomb to permit field assembly so that parts could be assembled from the outside of the container rather than from the interior through a large hand hole. A positive locking type filler cap was provided, eliminating the large filler cap which also served as the hand hole for assembly; and a reinforcing beam was added to absorb jettison loads from high speed aircraft. The chrome molybdenum alloy steel sway brace plates which were bolted to the skin of the bomb were replaced by an aluminum alloy plate welded to the skin, eliminating a critical material and twenty-four (24) sets of bolts, nuts, and sealing washers. The majority of spot welds were eliminated and replaced by fusion type welding with high speed automatically operated welding fixtures.

Functional improvements achieved by the redesign are a greatly strengthened structure which enables jettison release of the bomb from high speed aircraft, and greatly increased speed of assembly in the field because of the change from internal to external assembly methods.

Figure 5
M173 (before redesign)

Figure 6
M173A1 (after redesign)

Fuze, Igniter, Fire Bomb, M173A1

Estimated saving per unit.....$	.35
Estimated saving per million units	350,000.00

Only estimated savings resulting from the re-engineered item are given, since accurate comparable cost data were unavailable when this paper was prepared. This is due largely to the fact that the M173 with a machined brass head when last manufactured in 1952 was produced in large volume; and that no fuzes at all were produced during the intervening period of 1952 to 1954. Manufacture of the M173A1 fuze was started in 1954, but in a quantity too small to achieve a comparable economy of volume production equal to that of the last order for the M173 fuze before redesign. The estimated savings, however, are believed reasonably accurate, since they were made by manufacturers who had produced the M173 before its redesign.

(Continued on page 33)

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PLANNING—A KEY TO SURVIVAL

By Paul A. Longo

Chief, Planning Division
New York Chemical Procurement District
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It all starts with the strategic plans of the Joint Chiefs of Staff. The Plan contains the strategic scope and course of military action which must be taken for survival and serves as a basis for the computation of mobilization requirements by the Army, Navy and Air Force.

"What," "When," and "How Many" military supplies are needed to conduct this action? The "What" is tanks, planes, ships, bombs, rockets, radar, guns and ammunition; "When" is the time that these items will be needed for a national emergency; and "How Many" is the total number of items required.

While this "What?" "When?" and "How Many?" equation is geared to combat operational missions by the military strategists, the equation can become a reality only after the implements of war have been produced. The logistics appraisal is meaningless without the industrial partner, for the Industrial Partner, ready to produce war weapons, is essential for survival.

Industrial production needs require that industrial management be made a member of the mobilization planning team. The "What?" When?" and "How Many?" plan is the Department of Defense activity which works with the Industrial Partner to organize production potential into an important segment of the Mobilization Production Base.

The Department of Defense Production Allocation Program is one phase of this plan. This Production Allocation Program activity, modified and streamlined over the past several years, locates and evaluates industrial support necessary for military activities called for by the strategic military plans of the Joint Chiefs of Staff. This industrial support is the Industrial Production Base.

Since 1948, both military and industrial planning experts have conducted extensive studies on methods of converting industrial might into military power. These studies are the basis for the Production Allocation Program, the present formula for conducting mobilization planning with American industry.

Industry May Select Its Partners

Schedules of war production are arranged by the Army, Navy and Air Force with individual plants and corporations for manufacturing specialized military items in event of mobilization. By accepting M-Day production schedules, these facilities regardless of size will be the Industrial Partners in planning production and allocation of their output to the military user. Because the plan is voluntary, control of the distribution of production capacity by industry is a part of this plan. This means that during planning industry may accept or reject any military schedule proposed, or in turn, may reject an Army schedule and accept one from the Navy or Air Force. Briefly, this plan permits industry to select its partners. It is purposely designed in this manner so that the proper production capacity may be allocated to the military item which it is best adapted to produce.

Realizing the necessity for the development of this kind of comprehensive industrial mobilization planning, industrial management has responded without reservation. Industrial Management and the Department of Defense Field Planner—known as the Armed Services Procurement Planning Officer (ASPPO)—consider production schedules at rates balancing the needs of military plans. The voluntary agreements concluded indicate to the Joint Chiefs of Staff Planners the capabilities of industry and individual suppliers to furnish needed critical items. Plant by plant and item by item, planning on a national scale will create the military production base needed for survival, retaliation, and sustained combat.

This total plan means that within a minimum of time a base of production can be activated to provide most of the critical survival and retaliation needs of the United States military machine. This is why the plan is referred to as one of the keys to survival.

Many critical end items require considerable procurement lead time. Production will not be available to satisfy the needs of the period immediately following M-Day. There may be a difference between supply and demand during the early period after M-Day. Certain quantities of stock must therefore be on hand as current stockpile to form a mobilization reserve.

Importance of Production Schedules

The Mobilization Reserve Materiel Requirements is a segment of the Army Materiel Program and is provided for under the peacetime budget procedures to assure that a balance is maintained within the Mobilization Reserve Stock Program. This Reserve is determined by comparing mobilization requirements with scheduled mobilization production capacity. The capacity is reported by the Armed Services Procurement Planning Officer in the Tentative Schedules of Production, DD Forms 406, arranged with industry.

The acceptance of these schedules of war production by industry is by no means simply a "paper planning" exercise. On the contrary, each schedule plays an extremely important part in the nation-wide military plans. The "calculation" of the ability of the nation to defend itself and carry on a war if required is largely dependent upon these production schedules.

The strategic plans of the Joint Chiefs of Staff are directly dependent upon the support rendered by industry in the present mobilization planning efforts. The military planning representatives are acutely aware of the role of industry. Therefore, they critically analyze and evaluate industry's capabilities. Emphasis is placed on the manufacture of selected critical military end items for which industrial production capacity is allocated by the Services.

A capability study may show a lack of sufficient industrial production capacity. Stockpiling of an item or a critical component is then necessary. Many factors are

considered when stockpiles are required. Some of the more important factors are: deterioration rates, obsolescence, cost of the item, production lead time, and consumption rates. In the event standard items are replaced by newer designs, secondary use for training is considered.

There are items for which stockpiling is not feasible and production facilities are inadequate to meet the wartime military demands. The production base for such items is established by contracting with industry for engineering studies known as Preparedness Measures. Such study, as an example, may be for a plant design. If the situation is critical enough to justify further action and funds are available, plant construction is authorized.

Military Production Base

The military production base consists of presently available industrial facilities to be converted on M-Day and government-owned, stand-by plants and equipment. These stand-by facilities, designed and equipped to produce the specialized items, are maintained for use on M-Day. Government plants sold to private industry after World War II were sold with the stipulation that the Government could repossess them under the national security clause. The items presently produced at these plants are not necessarily the same items for which the facilities were originally designed. Reconversion, therefore, may be necessary.

The designs of government-owned facilities maintained in a stand-by condition are periodically reviewed by the planning engineers. Modern manufacturing techniques may be introduced to effect greater economy in operation and increased output. Technological changes resulting from industrial research are considered for improving the plant processes where applicable.

The mobilization production base is that industrial production capacity available for the manufacture of items to meet materiel requirements. The base consists of:

1. Planned production from privately-owned U. S. industrial facilities producing or capable upon convension to produce military items. The production capacity of these facilities has been allocated to the three military departments, Army, Navy and Air Force. The evaluation of this capacity is based upon the Schedules of Production, DD Forms 406, accepted by industry for the production of the military items. Management of each plant has voluntarily accepted the plan to convert from civilian to military production immediately should a national emergency arise.

2. Stand-by production consisting of idle government-owned facilities maintained in stand-by readiness for immediate use in the event of M-Day. Government built facilities leased or sold to industry are subject to recapture under a national security clause and are also considered as a stand-by reserve.

3. Industrial plants currently producing military end items constitute the operating base. From the standpoint of defense readiness, the operating base is most desirable.. A broad current production base will permit the fastest build-up to M-Day production rates through the increase in number of shifts. The Services endeavor to maintain a balance between M-Day materiel requirements and industrial production capacity. One major objective of the military is to achieve a rate of production at the earliest time after M-Day which equals or exceeds the rate at which the military items are required by the Armed Forces. The current operating production base is required to provide for the needs of the present peacetime U. S. Forces.

Planning Similar to Commercial Practice

Those firms which have accepted M-Day production schedules and have established as potential supply sources constitute the major part of the production base. Supply of the critical items required by the military forces in support of the strategic plans depends primarily upon these sources.

The many factors considered in the execution of the Program by field military planners have commanded the respect of industry. The combined management and "production line level" approach to the Program is similar to planning for commercial production.

A completed production plan may constitute all or part of the following: facility analysis, cost factors, lead time consideration, manpower requirements, tooling, inspection, packaging, raw materials, transportation, government-furnished components, and scheduling of controlled materials. Mobilization planning is conducted with subcontractors supplying critical components as well as end item producers and follows the same sequence of planning as is conducted with the prime producing facilities. The means is provided for the training of facilities through the implementation of educational production projects for those items not previously produced nor having a commercial counterpart. Through this device,tooling is acquired and production methods and inspection procedures are developed at the plant level and documented for future utility. This type of planning conducted on a managed cycle basis is targeted to develop the mobilization production base commensurate with mobilization requirements.

Dispersion of Sources Provided For

Military experts have contended that the delivery of lightening blows at production resources can liquidate the capacity of a nation to conduct war. The technological advances in the field of aeronautics, guided missiles, and the thermonuclear weapons have increasingly demonstrated the need for dispersion of the production base. Therefore, the production facilities established in support of the mobilization requirements are scattered throughout the country. There is much to be done in this connection but it is being resolved through gradual revisions to the existing plans and the relocation of production lines. This does not mean that the plans are duplicated for each facility. Segments of the total production requirements are assigned to different areas. As an example, a schedule for flame throwers may require the major output of several industrial facilities. These facilities are selected at locations strategically dispersed. Schedules are arranged so that in event of total destruction of a plant, the remaining facilities could make up the production deficit. This phase of planning is of primary concern when selecting sources of supply. Similarly, technical data and other production plans are maintained in strategically dispersed areas by the military agencies.

Continuing and close coordinating of these planning activities is essential. This is necessary in order to maintain the established M-Day production base current. Industry and the government, in a common effort, are providing the means whereby the military needs of the United States will be met in the event of total war. Without this industrial contribution to the planning effort, mobilization plans would be limited and incomplete. Because of this continuing cooperation, defense readiness is becoming a practical reality. The tax dollars appropriated for this purpose are relatively few, however, the returns are huge dividends in preparedness.

SIX STEPS TO SURVIVAL

(Following is an announcement by the Federal Civil Defense Administration issued at the Administration's headquarters, Battle Creek, Mich., on June 29, 1955.)

IF AN ENEMY attacked today, would you know what to do?

This is the question posed by the Federal Civil Defense Administration in a new leaflet entitled "Six Steps to Survival" which provides basic answers to the problems of family self-protection in the Hydrogen Age.

To make this information available to as many American homes as possible, the FCDA has arranged for publication of 12,000,000 of the leaflets, with distribution being made through civil defense and private organizations throughout the nation. "Six Steps to Survival" also may be purchased from the U. S. Government Printing Office, Washington 25, D.C., at a price of $3.25 per 100 copies.

In addition to its other distribution, the leaflet will be used throughout the year as a part of a national advertising campaign being conducted by The Advertising Council in behalf of civil defense.

Following, in condensed form, are some of the simple survival instructions contained in the leaflet:

Prepare Your Family for Emergencies

The family is the mainspring of civil defense. Get your family to work as a team in preparing for emergencies—whether from enemy attack or local disaster. Take the Red Cross First Aid and Home Nursing Courses. Keep a first-aid kit handy and well stocked. Lay in enough emergency food and water to sustain your family for a week. Keep this supply in your home shelter, and rotate or replace regularly to keep fresh. A flashlight, a battery-operated radio, a can opener, first-aid supplies, and emergency cooking and sanitation facilities should be kept there, too.

Learn the Civil Defense Public Action Signals

Memorize your local signals so that you will know what to do instinctively. The *Alert Signal*, which means attack is probable, is a steady blast of three to five minutes' duration. When you hear this, tune in on Conelrad (640 or 1240). Follow civil defense directions promptly. The alert signal will mean evacuation or mobilization of civil defense forces, depending on your location. The *Take Cover Signal* is a wailing tone, or a series of short blasts, of three minutes' duration. When you hear this, it indicates that attack is imminent and you must take the best available shelter.

Know the Conelrad Stations

At the first indication of enemy bombers approaching the United States, all television and FM radio stations will go off the air. All standard (AM) stations will likewise go silent. The Conelrad stations, 640 or 1240, are your surest and fastest means of getting emergency civil defense information and instructions. Mark those numbers on your radio set—*now!*

Follow These Evacuation Principles

The best protection against atomic or hydrogen bombs is—*don't be there!* In major cities, where there is sufficient warning time, this means pre-attack evacuation. Instructions will be broadcast over your Conelrad frequency following the *Alert Signal*. You will be told what evacuation route to take. Take enough suitable clothing and emergency food supplies with you.

Build a Home Shelter

Here are three reasons why everyone should have a home shelter.

1. In a sneak attack, or where there is insufficient warning for evacuation, any shelter is better than no shelter.

2. If you live far enough outside a target area to be relatively safe from blast and fire, there is still a chance you will be subjected to radioactive fallout from the bomb cloud. Even homes 150 miles or more downwind from major cities may lie in the possible fallout zone.

3. Home shelters are also good safety insurance against tornadoes and other types of natural disasters.

The best protection against radioactive fallout is an outdoor shelter covered by at least three feet of earth, and with a suitable device to filter out the dust. If you think you have some of the radioactive dust on you, take no chances—remove your outer clothing and bathe exposed parts immediately, using strong soap if possible.

Read These Facts About Radioactive Fallout

Normal amounts of radiation are harmless. It is only when it is present in concentrated amounts, such as are created by ground bursts of hydrogen or the larger atomic bombs, that radioactive fallout can cause serious injury or death to those who remain in the open without protective cover. Your civil defense officials, in consultation with the Weather Bureau, will keep you posted on the direction of possible radioactive fallout, should an attack occur, and tell you what to do. The best way to survive the hazards of radioactive fallout, or any other threat an enemy may use against us, is to be prepared—know the facts—learn what to do, *now!*

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JOINT MILITARY-INDUSTRY SYMPOSIUM ON PACKAGING

Assistant Secretary of the Navy Raymond H. Fogler has announced that the Office of Naval Material, in cooperation with all military services and the Department of Commerce, will sponsor the first Joint Military-Industry Symposium on Packaging and Materials Handling in Washington, D. C. on October 10, 11, and 12, 1955.

New military and industry developments in materials, methods, procedures and equipment will be described and displayed during the three-day session.

The theme of the conference will be: "What is new? What is needed?"

More than 400 industry and military packaging and materials handling specialists are expected. Industry will be represented by both manufacturers and consumers. Military offices concerned with the procurement, inspection, warehousing and transportation of government material will send representatives. All will be prepared to answer questions on government requirements proposed by industrial conferees.

Monday and Tuesday, October 10 and 11, will be devoted to the presentation of papers by military and industry representatives. Wednesday, October 12, has been set aside for round-table discussions. A committee representing all the military departments will select the topics of the greatest general interest for discussion and presentations.

Firms desiring to make presentations on new developments in the field, and individuals wishing to suggest questions for round-table discussions, should advise the Chief of Naval Material, Washington, 25, D. C. Information not placed on the agenda will be referred to the military activities most vitally interested in the subject.

Mr. Fogler noted that the continuing need for maintaining relatively large supplies of military material ready for instant shipment to any part of the globe has led to many improvements in packaging and handling. Commercial concerns, likewise, are engaged in producing new materials, processes and equipment to attract more customers or reduce production, handling and selling expenses. A better understanding of mutual problems is expected to result from the symposium. The exchange of information is expected to advance further the development of better and less costly means of protecting and distributing the supplies and equipment required to support military operations.

NCO'S AND SPECIALISTS ARE NOW SEPARATE RATINGS

THE ARMY'S new noncommissioned officer-specialist program went into effect on July 1. The program provides that noncommissioned officer identification and status be given only to enlisted personnel holding leadership positions. A separate category of enlisted personnel, called specialists, includes those who have technical and administrative skills.

Separation of the NCO from the Specialist is made in the top four pay grades. Thus, Specialists are in the same pay grades as NCO's in recognition of their technical or administrative ability.

Keynote of this program is to identify as an NCO the true leader, whether in a combat arm, technical or administrative service. Under the new plan, technical and administrative services are authorized NCO positions commensurate with their needs in the same manner as the combat arms.

Titles in the top four enlisted grades are as follows:

Grade	Non-commissioned Officer	Specialists
E-7	M/Sgt.	Master Specialist
E-6	Sgt. 1st Class	Specialist 1st Class
E-5	Sgt.	Specialist 2nd Class
E-4	Cpl.	Specialist 3rd Class

Noncommissioned officers continue to be addressed as Sergeant or Corporal as appropriate. Specialists are addressed by that name and wear separate distinctive insignia. The NCO ranks above all other enlisted personnel, regardless of pay grade.

Stressing the importance of noncommissioned officers as Army leaders, current regulations direct commissioned officers to utilize NCO's as appropriate in giving orders to troops, to encourage NCO's to execute orders on their own initiative and judgment, to employ NCO's as training instructors to the maximum practicable degree, and to see that NCO's are indoctrinated with the importance and responsibility of their rank and position within the command structure of the Army.

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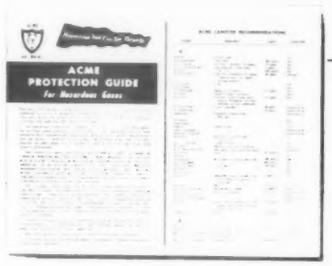
GAS HAZARDS and How to Overcome Them!



As a practical help to anyone who is confronted with the problem of hazardous gases, mists, fumes, smokes and dusts, ACME offers this valuable Protection Guide. It lists 433 of these hazards along with the ACME Gas Mask Equipment designed to give you dependable protection in each specific case. This vital information is available exclusively through ACME. Write for your copy today.

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CHEMICAL CORPS PROCUREMENT ORGANIZATION

By Lt. Col. William G. Willmann

Chief Industrial Division
Headquarters, Chemical Corps Materiel Command
Baltimore, Md.

The present age of potential nuclear warfare has made it necessary for the Chemical Corps to provide a procurement organization with sufficient flexibility to meet any strategic situation. The organization must have maximum flexibility with maximum delegation of responsibility and authority. In addition it must be keyed to two possible types of mobilization. The first is a full mobilization effort for an all-out war when the mobilization plans as made will be implemented. The second type of mobilization is the type that was experienced during the Korean emergency, a partial build-up when the plans made in previous years for mobilization could not be utilized to their maximum. The organization must be such that if the first type of mobilization comes and an all-out industrial effort is required, the organizational system will function automatically without need for consideration of organizational responsibilities or location. The best plans made will not fit all the circumstances of any mobilization. Plans must therefore be made and organizations developed which will permit the absorbing of the initial shock of war, thereby giving those responsible for the procurement mission a going organization and time to consider the magnitude of the mobilization effort, the objectives of the United States at that time, and an adequate opportunity to realign and reorganize. The Chemical Corps procurement organization has been designed and fitted to meet these needs.

Procurement Roles of New York and Chicago

The Chemical Corps Industrial Mobilization planning effort is initiated by the determination of mobilization requirements for end items by the Office, Chief Chemical Officer. Requirement schedules are issued to Headquarters, Chemical Corps Materiel Command for action. Headquarters, Chemical Corps Materiel Command establishes industrial mobilization mission assignments for the various arsenals and Chemical Corps Procurement offices and directs the broad aspects of the program. The responsibility for the mobilization planning for end items to be produced by industrial suppliers is assigned and centralized in the New York Chemical Procurement District. Thus planning within the Corps is on an end item basis, with the New York Chemical Procurement District responsible for all end items procured in industry and the arsenals responsible for coordinating all planning for items which they are to make, utilizing the Chicago District as their central procurement office for components. The other Chemical Corps Procurement districts located in Atlanta, Dallas, San Francisco, and the Boston Sub-Office of the New York Chemical Procurement District are utilized in supporting roles to New York and Chicago.

Strategic Importance Of Smaller Districts

The role of the smaller procurement districts can be better analyzed after considering the strategic aspects of Industrial Mobilization planning. There are many facets to be considered, among these are:

(1) The strategic dispersion of suppliers, so that if the New York area is devastated by a major attack the country will not lose its total capability for the production of a given end item. Therefore our mobilization requirements for each item are divided and dispersed nation-wide.

(2) The strategic dispersion necessitated in light of possible attacks on the transportation system.

(3) The dispersion of plants for common items, for example, gas masks, near ports of embarkation through which they will be shipped, thereby reducing the potential load on the transportation facilities during war.

(4) For those components being procured in support of the Chemical Corps arsenals, proximity of the suppliers to the Chemical Corps arsenal being supported.

It is therefore obvious that the smaller procurement districts serve a very vital part in our overall Industrial Mobilization planning effort. Each end item procurement planning program is divided and assigned to geographic areas nation-wide to provide for the necessary strategic dispersion.

Production for Arsenals Is Likewise Dispersed

Major components procured for the Chemical Corps arsenals are likewise dispersed strategically but in close proximity to the supported arsenal. The area assignment of end item schedules nation-wide is made by Headquar-

ters, Chemical Corps Materiel Command after coordination with the responsible planning district and the supporting districts. In spite of the assignment of responsibility for certain portions of each end item or arsenal component program to another district, the overall responsibility for detailed planning with Industry rests either with the New York District for end items or the Chicago District for arsenal components. All planning accomplished by other districts is funneled through the parent responsible district.

This organization provides the flexibility needed to meet any foreseeable type of mobilization. Should full mobilization be directed, orders for initiation of Industrial procurement would be funneled through Headquarters, Chemical Corps Materiel Command to the responsible arsenals and the New York Chemical Procurement District. The arsenals and the New York District in turn would issue orders to their supporting district offices for the initiation of procurement. Each district office, including Atlanta, Dallas and San Francisco, would immediately initiate negotiations with their planned suppliers. Contracting would be done in each of the districts. Program coordination of procurement would rest in the New York and Chicago District offices. Thus the Industrial Mobilization effort will be started immediately upon receipt of orders from higher authority to initiate mobilization procurement. There will be no need for immediate consideration of organization or mission assignments. Strategic dispersion will be accomplished through sound advanced planning and the initial shock of mobilization will be absorbed by the entire existing procurement organization of the Corps.

System Is Designed to Work in Case of Attack

The organization further provides for dispersion of program control. Procurement can proceed without detailed instructions from higher authority and at least a portion of each procurement program can proceed in spite of the loss of one or more Headquarters or Procurement District offices by enemy action. This type flexibility is considered of the utmost importance and the present system provides for detailed planning information available in these offices to supply the necessary military goods required. Contracts awarded in other district areas can be administered by these other districts.

A further advantage of the present organization is the insurance of maximum coordination of Industrial Mobilization planning with current procurement activities, since all current procurement is accomplished in the New York and Chicago Chemical Procurement Districts through which all industrial mobilization planning is coordinated. Maximum use can be made of planned suppliers in meeting our current procurement requirements and knowledge gained through current procurement operations can be applied to the maximum in achieving our Industrial Mobilization planning objectives. Technical difficulties encountered during current procurement can be reflected through changes and improvements in our mobilization plans. Government owned tooling can be corrected, modified or disposed of in order to insure that tooling held for mobilization purposes is adequate to accomplish the mobilization mission.

Organization in Depth Not One of Duplication

Organization in depth to meet the Industrial Mobilization mission is not one of duplication or waste. The detailed planning which must be done with each planned industrial supplier is done in only one location, whether it be New York, Chicago or one of the smaller districts. The central offices located in New York and Chicago are clearing houses where all detailed plans are assembled, reviewed for completeness, adequacy, consistency, and coordinated with current procurement operations. Each Materiel Command installation maintains a complete file of current drawings and specifications of Chemical Corps items to accomplish its detail planning and to provide technical service to current and potential contractors in their respective areas. The use of geographically distributed district offices means considerable savings in man hours of travel, communications and, in addition, takes advantage of local knowledge of raw material, labor, and general business problems. These advantages would not be possible if all planning were conducted from one central point.

Our present procurement organization is flexible and has the depth to meet, within a reasonable period of time, any foreseeable mobilization situation. It provides a streamlined organization capable of accomplishing the current procurement mission with a maximum of coordination with Industrial Mobilization planning. It provides a nucleus staff in the smaller district offices with the competence to proceed with procurement operations should circumstances dictate. It further provides for the maximum de-centralization of operations and the maximum delegation of responsibility and authority to field elements. Above all it provides a team organization which can perform regardless of the loss of one of its members, and provides an organization which can function automatically and provide the top planners the time necessary to analyze the mobilization situation which the country will face. It will provide time to make necessary plans and organizational changes to fit the situation, while still meeting the initial impact of mobilization.

LT. COL. WILLIAM G. WILLMANN

Commissioned a second lieutenant in May 1942, Colonel Willmann served as an Air Force Chemical Staff Officer in Europe from 1943 to 1947, a period of 38 months. During that time he was in Normandy, Northern France, the Rhineland and Central Europe. He came to Materiel Command of the Chemical Corps in 1951, was made Assistant Chief of the Industrial Division in 1952 and has been Chief of that Division since December, 1953.

Among Col. Willmann's awards are the Bronze Star Medal, Army of Occupation Medal, Army Commendation Ribbon, the National Defense Service Medal and the Armed Forces Reserve Medal. Col. Willmann was born at Suffern, N.Y., May 7, 1921. He has a B.S. degree in chemistry from Lehigh University.

GAS WARFARE RESEARCH GROUP—1917

Some of Those in Picture Not Identified. Can You Give Their Names?

—U. S. Bureau of Mines Photo

BUREAU OF MINES WAR GAS INVESTIGATIONS, 1917 Advisory Committee, Consultants and Directing Staff at American University Station. Photograph taken on steps of Ohio Hall at American University, Washington, D.C. Identification of persons by Arno C. Fieldner, March 1954.

THE GROUP photograph printed here is from the archives of the Bureau of Mines, one of the several government agencies that participated in World War I gas warfare preparations before unification of the program under the Chemical Warfare Service of the Army.

The picture was taken in 1917 at the experimental station for gas warfare established at the American University, Washington, D.C. The group includes the advisory committee, consultants, and directing staff for the war gas scientific investigations which were among the activities that preceded the establishment of the Chemical Warfare Service under Major General William L. Sibert as its first chief.

This photograph was furnished the JOURNAL for reproduction by Colonel Harry A. Kuhn, chemical consultant, Washington, D.C., who received it from Mr. A. C. Fieldner, chief fuel technologist in the Bureau of Mines. Mr. Fieldner was one of the original American University gas warfare group and appears as number 13 in the group photograph. He has been able to identify a large number of the group. The names of those who have been identified and their professional titles or associations at the time the picture was taken, so far as known, are listed here by numbers corresponding to position numbers as shown in the accompanying key drawing.

Mr. Fieldner, Colonel Kuhn, and others who were associated with the World War I chemical warfare organization, would like to have the names of those persons in the picture who have not been identified. JOURNAL readers therefore are requested to send in to the JOURNAL any of the missing names which they can furnish.

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1. — — —
2. Dr. Charles L. Parsons, Chief Chemist, Bureau of Mines, and Secretary, American Chemical Society.
3. Dr. Reid Hunt, Professor of Pharmacology and Toxicology, Harvard University.
4. Dr. E. C. Franklin, Professor of Chemistry, Leland Stanford University.
5. Rear Admiral Ralph Earle, USN, Chief, Bureau of Ordnance.
6. Mr. Van H. Manning, Director, Bureau of Mines, U.S. Department of the Interior.
7. Dr. William H. Nichols, General Chemical Co.
8. Dr. William Hoskins, Consulting Chemist, Chicago, Illinois.
9. Dr. H. P. Talbot, Head of Chemistry Department, Massachusetts Institute of Technology.
10. Mr. George A. Burrell, Chief, War Gas Investigations, U.S. Bureau of Mines.
11. Dr. E. Emmet Reid, Professor of Organic Chemistry, Johns Hopkins University.
12. Dr. Francis P. Venable, Head of Chemistry Department, University of North Carolina.
13. Mr. Arno C. Fieldner, Chief, Gas Mask Section, Bureau of Mines War Gas Investigations.
14. Dr. Milton Winternitz, Professor of Pathology, Yale University.
15. Dr. Harold C. Bradley, Professor of Biochemistry, University of Wisconsin.
16. Lt. Commander A. H. Marks, U.S. Navy.
17. Rear Admiral David W. Taylor, U.S. Navy, Chief, Bureau of Construction and Repair.
18. Col. Marston T. Bogart, USA, Chemical Warfare Service, and Professor, Organic Chemistry, Columbia University.
19. —
20. —
21. —
22. —
23. Dr. George A. Hulett, Professor of Physical Chemistry, Princeton University.
24. —
25. William A. Hamor, U.S. Army.
26. Dr. Charles H. Herty, Editor, *Industrial and Engineering Chemistry.*
27. Mr. Robinson, Bureau of Mines.
28. Dr. Yandell Henderson, Professor of Physiology, Yale School of Medicine.
29. —
30. Dr. J. F. Norris, Professor of Organic Chemistry, Massachusetts Institute of Technology.
31. Dr. N. K. Chaney, Research Chemist, National Carbon Company.
32. Mr. George A. Richter, Research Engineer, Brown Paper Company.
33. Dr. Charles A. Kraus, Professor of Chemistry, Worcester Polytechnic Institute.
34. Dr. C. A. Boord, Professor of Organic Chemistry, Ohio State University.
35. Dr. Richard A. Tolman, Professor of Physical Chemistry, University of Illinois.
36. —
37. Dr. F. G. Cottrell, Assistant Director in Charge of Research, Bureau of Mines.
38. —
39. Dr. C. A. Browne, Bureau of Chemistry, U.S. Department of Agriculture.
40. —
41. —
42. Mr. Huff, Solicitor, U.S. Bureau of Mines.
43. Dr. J. H. Walton, Professor of Chemistry, University of Wisconsin.
44. Mr. Samuel P. Mullikin, Bureau of Mines.
45. Mr. B. B. Fogler, in charge of Mechanical Development of Gas Masks, Bureau of Mines.
46. Mr. H. H. Clark, Electrical Engineer, U.S. Bureau of Mines.
47. —
48. —
49. —
50. Lt. Commander Theodore S. Wilkinson, U.S. Navy.
51. Col. Auld, British Army, Liaison Officer on Offense Research.
52. —
53. —
54. Dr. George C. Wislocki, Professor, Comparative Anatomy, Harvard University.
55. —
56. Dr. Arthur B. Lamb, Professor of Chemistry, Harvard University.

(In an address to the Nuclear Engineering Class, North Carolina State College, Raleigh, N.C., on July 18, 1955, Mr. Roddis discussed today's outstanding industrial question: What will commercial atomic power cost? His speech, touching upon many matters of special interest to A.F.C.A., including the technical manpower problem, world fuel resources, the contributions being made by private enterprise and financing to atomic power development, is presented in full herewith.)

PRESENT STATUS OF ATOMIC POWER IN THE UNITED STATES

By Louis H. Roddis, Jr.

Deputy Director, Division of Reactor Development
U. S. Atomic Energy Commission

In 1947, I assisted in the preparation of a report which had the same title as this talk, "The Present Status of Atomic Power in the United States." That report found that then only a handful of people, probably not over 50, were working on the problems of atomic power in this country. The only serious effort—the Daniels Pile, had been terminated by then. There were several separate and disconnected groups working a minor way, but nothing resembling a reactor program.

The situation today, in 1955, is considerably more encouraging. During the intervening years, some 400 scientists and engineers have received formal training in the atomic energy field and over 4,000 have been brought in through the process of retraining on the job. Today, therefore, we find something in excess of 5,000 scientists and engineers working on atomic power problems. Most of these are working for the Commission's contractors. Another considerable number are working for the armed services or their contractors, and a substantial number are working for private capital. This sounds like a significant achievement—an increase by a factor of nearly a 100 in 8 short years. However, it is probably more appropriate to point out that there are *only* 5,000 engineers and scientists now working on these problems. This number represents but a small fraction of 1 per cent of the total number of engineers and scientists in the country—and a not much larger fraction, still less than 1 per cent, of the total number working in the field of research and development. This is in contrast to the chemical industry with over 10 times as many, or the electrical industry with over 20 times as many people working.

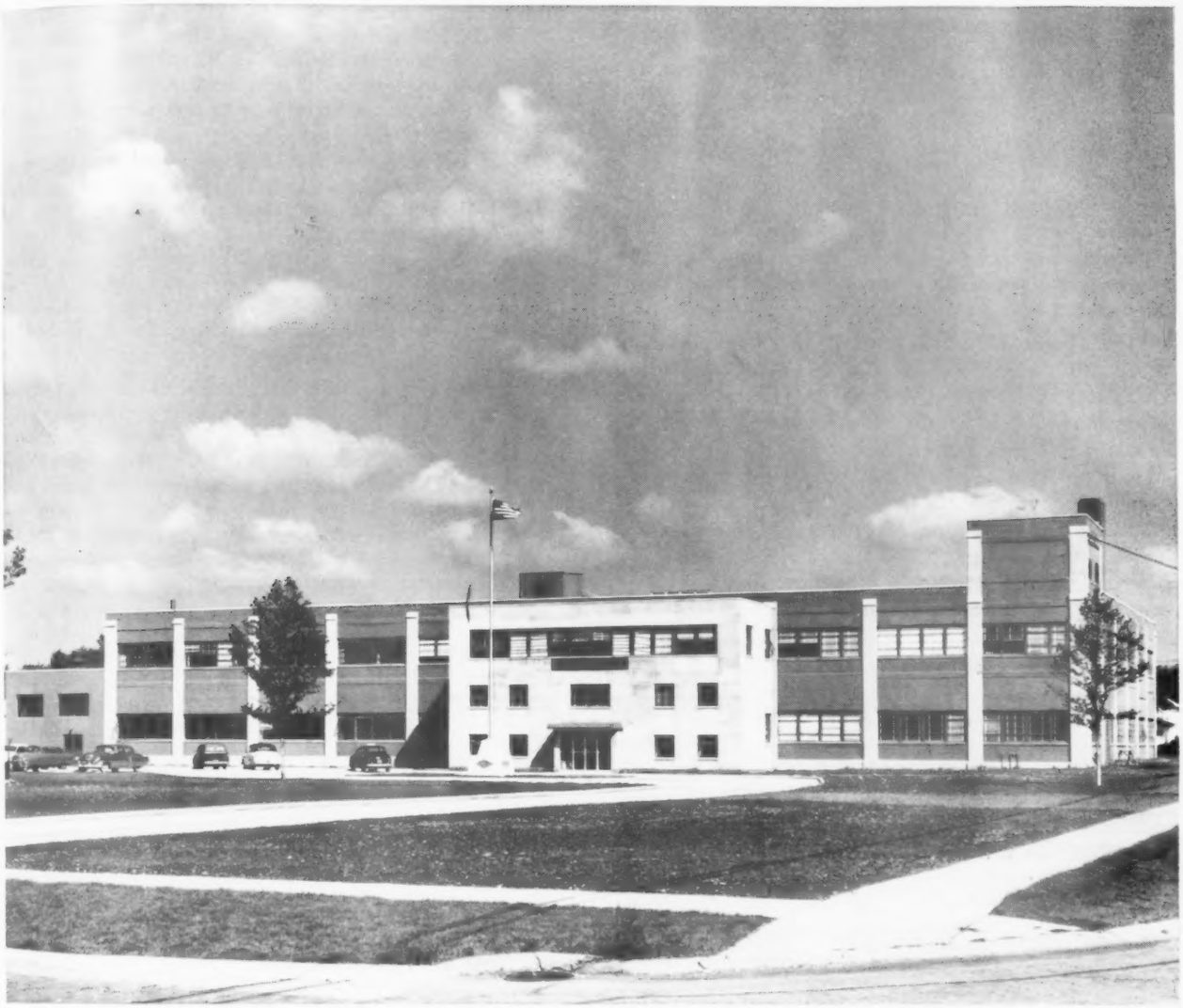
It is interesting to note that the types of people who are employed in the reactor field do not represent any narrow group of "nuclear engineers" or "nuclear physicists." They represent a number of scientific and engineering fields of specialization. They have obtained the necessary additional technical know-how to enable them to practice their normal specialization in the atomic field. A study of the employment history of the commission's reactor development laboratories will show that no one field of engineering or scientific specialization has contributed a disproportionate number of people to our programs. Mechanical engineers, chemical engineers and physicists represent the largest groups, but even taking all three together they represent less than half the specialties involved. The purpose of this course which you are attending here is to spread this base of technical personnel trained in their individual specialties, by providing a background of knowledge in the nuclear field which will permit them to play a broader part in the atomic power field in this country.

I believe that by far the largest problem in atomic power today is that of *technical manpower*. With the rapidly expanding requirements of our military reactor programs, as well as the civilian power reactor programs, there appears to be no end in sight to requirements in the technical manpower field. I am extremely happy to see the efforts bearing fruit here at North Carolina State to produce more engineers and scientists for work in this field.

In comparing the status of atomic power in 1947 and today we find that something more has been achieved than the mere bringing in of additional scientists and engineers. What was a scientific theory in 1947 has now been actually demonstrated in several ways. There is certainly no longer any question that it is technically possible to generate power from nuclear fission. Military power reactors are today a reality.

It is important to note, however, that no power reactor now operating is in itself economical. Indeed, none of them was ever expected to be. All of the nuclear power plants which have been operated to date have been developed either for experimental or military purposes. I believe the outstanding fact of the last eight years is actually that useful atomic power has been developed in so many different ways by so many types of reactors.

I am sure that all of you are familiar with the long-range position of nuclear power relative to the fossil fuels. It is perhaps most aptly expressed by the use of Palmer Putnam's "Q" energy unit. One such study indicates that the total fossil fuel available in the world is probably in the order of 30-50 of these energy units, whereas the total availability of nuclear fuels is more in the order of 1700 units. There are, of course, arguments as to how much of both the conventional and nuclear fuels will be recoverable; but the point is that next to solar energy, which of course is virtually limitless, nuclear fission fuels represent a substantial availability after our conventional fossil fuels are expended. Assuming that our present civilization continues to pro-



Diamond makes room for radiation research

Exploring potential uses for atomic energy in chemical processing is one of the main purposes behind the modernization and expansion of DIAMOND's Research Center at Painesville, Ohio.

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gress, there is then no doubt that nuclear fuels will be used in substantial quantities in the future.

The question then resolves itself to—what is the "future"? in other words, how far are we away from that elusive goal of "economic nuclear power"? I should first state that the term "economic" in itself, in this context, is subject to many and various definitions. In the first place, since any problem of economics of any power plant is tied up to the question of how long that plant will in fact continue to operate, no really definite answer is possible until the plant has operated through its predicted life span.

The real problem is that in this matter of economics, "broad brush" treatments are not adequate. Yet "broad brush" treatments are all we can give today. Costs are always important to within a few percentage points; yet the status of atomic power plants today does not permit estimating cost either for initial investment or for operation with anything like this degree of precision. Assumptions can, of course, be made; and the economic studies then cheerfully proceed until a "cost of nuclear power" is arrived at which is a number that is remembered long after the qualifying assumptions are forgotten.

The only real answer that can be given is that no one knows what the true costs of atomic power are today. I have seen situations in the last year where pieces of equipment for nuclear plants were ordered on a firm price basis—where the spread between high and low bids has covered a factor of 7—and where the low bidder's price was lower by a factor of 5 than the engineer's estimate. I might add that this situation has occurred in cases where the low bidder stoutly maintains that he is not losing money on the job. When responsible firms are making bids on equipment which vary over such a wide range, it seems obvious that estimates of the cost of a complete plant which includes these components are also going to fluctuate widely. Operating costs are in a similar class with fuel element life, plant reliability, size of the required labor force. All are subject to "educated guessing."

In the matter of economics, what will count from the construction cost standpoint is what the actual returned cost of the plant was when finally built. From an operating standpoint, the history of how long and how satisfactorily the plant functions will govern its economic position. Today, these are both unknown. At the present moment, the arguments between the protagonists of different types of nuclear power plants are often heard; yet, the differences in assumptions which these protagonists must make are much greater than the differences between the various reactor systems. It will only be after full-scale plants have operated successfully over a considerable period that one will be able to state on any realistic basis what type is actually the best. Nuclear power plants, with inherent capital costs higher than the usual conventional fuel plant, will probably come out with a different balance between capital and operating costs than is the case for either thermal or hydro plants. This balance point will probably differ also, depending on the economic system under which the plant is constructed. The importance of the cost of money in a given economic system has an important bearing on what type of plant is built.

If then the economy of nuclear power is such an unknown, what is being done? We are very hopeful that the economy will work out—and therefore a number of things are being done. Our hopefulness is greatest in the area of capital costs of construction for large plants. Our unknowns are greatest in the fields of operating costs, experienced manpower, reliability and the subsiding fuel cycle problems.

First, I should note that the Commission is vigorously continuing the military reactor programs which have already contributed significant items of technology to the civilian program. This kind of contribution of military technology to civilian use has many historical precedents, the most notable in recent history being the airplane engine and the locomotive diesel engine which were derived from military aircraft engines and submarine diesels.

As a second item, the Commission is actively continuing to build new reactor experiments to prove out specific and new types of reactors. These reactor experiments are conducted on a scale which is not expected to give the final economic answers, but which is expected to advance the technology to the point where the construction of large scale, and hence very expensive, units can be seriously contemplated. There are three reactor experiments under construction now; these are: the Sodium Graphite Reactor Experiment, at Santa Susana, California; the Homogeneous Reactor Experiment II, which is now at Oak Ridge; and the Boiling Water Experiment Reactor, at Argonne. The Commission hopes to put under construction this year a fourth reactor experiment—the Experimental Breeder Reactor No. 2. In addition to these four, the Commission is seriously considering several other types for the construction of reactor experiments. In particular, the organically moderated reactor experiment using a hydro-carbon moderated coolant and the liquid metal fuel reactor using bismuth uranium alloy as the fuel and coolant material are being considered. Several industrial companies have already indicated interest in these reactors. We hope that many others will develop an interest in these concepts and will communicate this interest to the AEC.

As a third item, the Commission is maintaining a vigorous program in the areas of fuel element processing and fabrication, irradiation testing, experimental reactor physics, waste disposal, reactor safety, and other problems relating to the entire atomic power industry as a whole. All of these steps, however, are not enough to give us economic commercial power. We must also build full-scale units and operate them. To have any significance, engineering and economic estimates must be based on substantially full-scale experience.

In the most important area of constructing full-scale central station power plants, private financing appears to be entering the picture. In the last year or so six units have been proposed or started. All are based on technology developed in the past by either one of the military reactor projects or one of the first group of reactor experiments. These six full-scale reactor projects represent different degrees of government and private capital investment.

The first of these historically is the Pressurized Water Reactor, now actually under construction at Shippingport, Pennsylvania. This is a Commission project to which a private company, the Duquesne Light Company, is making significant capital and operating cost contributions. This project was instituted under the Atomic Energy Act of 1946.

The second project in point of time is a privately

financed nuclear power reactor based in large part on the same pressurized water technology of the Nautilus reactors on which the Pressurized Water Reactor is based. This Atomic Power Station is proposed by the Consolidated Edison Company of New York for construction and operation under a license to be granted by the Commission in accordance with the provisions of the Atomic Energy Act of 1954.

The four other proposed large-scale units are part of the "Power Demonstration Reactor Program" instituted by the Commission in January of this year. The Commission is still considering these proposals. These four proposals are: (1) Commonwealth Edison Company of Chicago, acting for a combine known as the Nuclear Power Group; (2) a group of companies headed by the Detroit Edison Company; (3) Yankee Atomic Electric Company, representing a combine of New England power companies; and (4) the Consumers Public Power District of Columbus, Nebraska.

These four power demonstration proposals taken together with the Pressurized Water Reactor and the Consolidated Edison license request represent a total nuclear power plant capacity of approximately 700,000 KW of electrical capability and a total investment which is estimated to be in the order of $250,000,000, approximately 15 percent of which represents government funding—chiefly for the Pressurized Water Reactor.

These six big full-scale plants, including the rather significant variations between the three pressurized water proposals, really represent six distinct types of reactors. If all of them are built, we can expect, by 1960, to know on a reasonably firm basis what the true construction costs were of each of these six types of reactors. We should also know by then, or shortly thereafter, what their actual power capability is and therefore have some firm figure for the capital costs of such large plants.

It will not be until several years after that, however, that operating costs, plant factors and fuel element life will be sufficiently well determined that a direct measure of the operating costs will be available. None of these big six will in itself be economical at first, but each will lead the way in its own field. The contribution these projects will make to power reactor technology should amply justify any costs in excess of what the best conventionally fueled plant might have cost. It is hoped that all of the plants will have operating costs that compare favorably with those of some very old peak load stations which some of the companies involved are now operating.

The future trend of civilian nuclear power plant construction, after about 1962 or 1963 will depend most heavily upon the economic success of these first large scale units.

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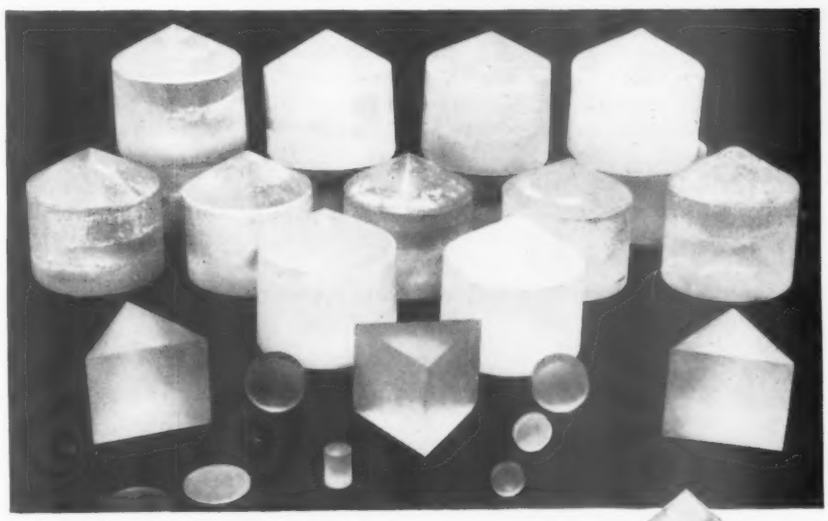

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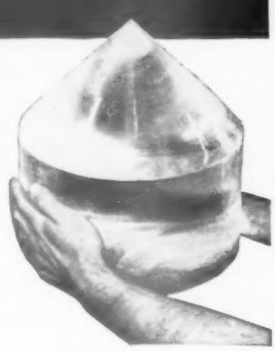

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USE OF THE TECHNICAL REPORT IN MILITARY PLANNING*

By DONALD H. HALE

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Deputy Commander, Research and Engineering Command
Army Chemical Center, Md.

IN DISCUSSING the use of the technical report in military planning I propose to interpret the term "Military Planning" as planning for tactical or strategical operations. The scientist and engineer records his experience and, to a degree, his opinions in the technical report. The military man decides upon and plans changes in military doctrine, or the accepted military way of doing things, and also plans organization, equipment, logistics, and training based upon the technical report of the researcher. Actually, compared with the way it usually works, I have put the cart before the horse. I might better say that the military man plans changes in organization, equipment, logistics, and training in order to take advantage of new developments. After this is done he changes the military doctrine in order to take full advantage of the new organization and equipment. In times of emergency the strictly military planning often follows very closely after the development work is finished and the technical report is written.

Vannevar Bush ("In Modern Arms and Free Men") states that by 1918 the principal devices had been tried out in practice— there were automatic guns, self-propelled vehicles, tanks, aircraft, submarines, radio, poison gas— mass production had appeared—the petroleum, automobiles, chemical, and communication industries had approached maturity. And Dr. Bush also states that the world did nothing at all about this in the period between the two wars.

If we grant that Dr. Bush's analysis of the situation is essentially correct, and I think we must, then we must decide that something was very wrong in our country and that we could have been much better prepared in December of 1941 than we in fact were. In these troubled times it is not likely that we will again be allowed the time to plan the application of advances in science and engineering, made in a period between wars, after the fighting breaks out.

ONE MIGHT SAY, somewhat dogmatically, that the failure of the country to plan to take military advantage of technological advances during the period between the two wars was due to the failure of the technical men to sell their ideas to the military, the Congress, and to the American people generally. Actually, as we all know, this is a much too simplified generalization. During most of this period the American people just were not interested in such things and a regiment of Daniel Webster's could not have roused them from their apathy. Today the situation is quite different. But even after December of 1941 and while we were engaged in a life and death struggle we still had considerable difficulty in utilizing the products of the laboratory and civilian engineering in our war effort. All sorts of reasons were given for our difficulties. The civilian technical worker was inclined to say that the military man had so little technical training and so little knowledge of technical matters that it was almost impossible to get him to accept any new idea. The military man on the other hand was inclined to view all civilian technicians as impractical and dreamers and applied the term "long hairs" to the lot. I am happy to report that these days one almost never hears this term of derision used by military men. It appears that we do make progress.

Actually the military man's position, when he must decide upon the adoption of a new device, a new technique, or a new weapons system, is a most difficult one. Almost always he must decide to abandon a system that has worked successfully in the past, for after all we have won our wars. His decision to adopt a new item or a new system almost always means that much costly material must be junked before it is worn out or used up. His decision may well have real impact upon the production of the country and this is a serious problem in the middle of a war. And further, and most serious of all, when the military man makes the decision to adopt new materiel, or procedures, he is to a point gambling with the lives of many young men. He must be absolutely certain that the adoption of the new device will at the very least not cause the nation to expend more lives in the winning of the war at hand or the war which we may have to fight and to win

ALL OF THIS TENDS to make the military man cautious and conservative as who among us would not be if we were forced to make decisions of such magnitude in such a climate. In the language of the salesman the military man is a tough prospect. And yet the technical man often must, if he is to be true to his country and to himself, use every means at his disposal to sell a new idea to the military. And all of us who have any part these days in military research and engineering have a great responsibility to keep senior military men fully informed of the progress of our work and constantly to point out the possible applications to military operations. We do this of course through the medium of the technical report. And as I use the term, the report may be written or oral and it may be studied or delivered formally in the briefing room or informally in a club car, over dinner or even at a cocktail party. We are fortunate today since the technical men of the country are fully aware that the responsibility for planning for the use of the latest technological advances is no longer to be borne by the military alone. The scientist and engineer are ready to assume a large share of responsibility.

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I am pointing out that the scientist or engineer who really believes in himself and his ideas and in his work must use every avenue to sell the product of his work. If one is inclined to scoff at the informal and indirect approach I call to your attention the Shepley-Blair report. Also I would recall the manner in which the possible use of atomic power for military purposes was brought to the attention of the President as the last war broke out.

I have been arguing certainly that the technical report is always important and further if the material reported upon has a bearing upon our national defense it is doubly important. The report must certainly follow some format or other. Many are used and as long as the material is presented in some logical manner I do not think that the format is too important. The language used in the type of report I am discussing is of the utmost importance. Here the reporter is not writing entirely for the reader who is skilled in some technical field and who understands the language of the field. We might as well face it, so complex has become the governmental research and development structure that reports will often be read by men who are by no means expert in any technical field. Yet these non-technical readers must often make far-reaching decisions based upon knowledge gleaned from the report. Therefore the language used becomes of the utmost importance. We must make every attempt to minimize the use of any vernacular that is peculiar to us or our group and to the workers in our field. I find the young doctor of philosophy particularly clumsy at writing his report in good English; English in which the use of simple words and phrases predominates. Possibly he feels that he will be a disgrace to his university and to the men who taught him if he fails to demonstrate clearly that he is capable of using the technical terms that are peculiar to his craft. I shall have more to say about the language used in the report in a moment.

THE REPORT MUST arrive at some conclusion. Administrators of scientific work and other planners must constantly make decisions concerning technical work which they cannot follow closely, if for no other reason than they do not have the time. These people are most interested in what the man in the laboratory thinks of his work, and the technical worker should sum up his ideas in his conclusion and sometimes in his recommendations. Yet many technical men seem absolutely incapable of coming to any conclusion concerning their work. Or possibly the trouble is that they write an indefinite conclusion and make no recommendation on the grounds that this sort of action will relieve them of criticism in the future. Yet the conclusion is the meat of the report for many readers and it is particularly important for the busy administrator and for the reader who is not an expert in the field reported upon.

Without expending much effort I found the following conclusion in a report prepared in one of the Department of Defense installations. This report incidentally was one that most certainly will be read by military officers who must plan for operations. The conclusion read, "The closed houses and slit trenches afforded some protection from the effects of the cloud."

Now perhaps the technical man who is skilled in the particular field reported upon here can read this report and make up his mind whether the protection afforded is small or considerable. But what of the non-technical reader? He is probably lost. It would have been much better if the writer had stated quantitatively what degree of protection was provided. He might be excused for hedging a bit and qualifying his statement by saying that his results were for some reason not too good and his estimate might well be in error by such and such a per cent. But even so, he would be giving the non-technical reader a much more precise idea of what he actually observed and believed than is given by the indefinite statement as written.

That the technical report is often used as the basis for military planning can hardly be questioned in this day. I might add in passing that the technical report is also often used by the administrator, who unfortunately is almost never highly skilled in the field reported upon, as a basis for decisions concerning the continuing effort to be placed upon the work reported upon. Two examples of how the technical report may be used directly by military men might be interesting.

THE FIRST IS a classic. In the First World War the German chemists lead by Haber conceived the idea that the stalemate upon the Western Front might be broken by the introduction of gas warfare. They reported this to the German General Staff and convinced the Chief of the German General Staff that gas should be used. The technical problems involved were solved brilliantly by Haber, but it is clear that the military were inadequately informed of the potentialities present. Hindsight tells us that if proper preparations had been made to take advantage of the gas attack, the impact on the Allies might well have been overwhelming, and we must admit that the failure involved must be charged to the technical people. They had failed in their reporting.

However, the scientist does not always, by any means, fail to convince the military man. During the last war our troops ran into difficulties in the Pacific where the terrain was such that the Japanese could fortify caves. A team of military-civilian scientists was set up to study the problem. This team worked at an Army proving ground in our West. Their report indicated that flame throwers of various types would be of real assistance provided that special small troop organizations were set up to handle the weapons which were at hand and that special types of training were given. Within a short period of time such specially organized, equipped, and trained troop units made their appearance in the Pacific. It is commonly known today that these organizations were of real help in many fights. This was a case where the technical men did an excellent job of reporting their work and made a real contribution to the war effort. There are hundreds of other such examples that could be cited from the experience of the last war.

Returning to the difficulties experienced when language is used in a clumsy fashion, I picked at random a report written, again, in one of the Department of Defense laboratories. I came up with a report that discusses some of the problems associated with the clean-up of areas and materiel following an atomic explosion. The report was written primarily for military staff officers who must use it to write doctrine and training manuals for the use of troop commanders. I found this sentence, "Dosage varies directly with the amount of contamination and with the length of exposure during decontamination." This sentence in no way conveys a precise idea. The ideas conveyed, at least to me, are not technically correct. I have no thought here of going into a technical discussion of the mechanisms by which penetrating radiation damages the human body. But I believe that the writer was trying to say that the radiation dose to which the worker might be exposed would depend upon the amount *and the type* of radioactive material in the vicinity and also upon the length of time during which he exposed his body to the radiation. I am quite certain that the reader of this

report would gain quite incorrect concepts unless he had considerable knowledge of the physical and biological laws involved. The non-technical reader might draw quite incorrect conclusions from such a statement and set dangerous procedures in action.

THERE IS NOTHING to be gained by presenting more examples and further belaboring the point that a clumsy use of the language can make a report useless or even dangerous. I expect that you all have many examples as bad or worse than mine. The technical editor must always fight against the poor use of the language. This may well be his most weighty cross. And he must bear it until he succeeds in training and convincing the writers of the reports which he edits.

In conclusion I would like to restate my thesis. Today the scientist and engineer report their work both orally and in writing. But because of the size and the complexity of our research and development organizations the worker's product is more and more being analyzed and acted upon following a study of his written report. This report is often studied by men who have no great technical competence in the field. Those of us who work in the laboratories of the Military Services of the Department of Defense, or who work in laboratories where contract work is done for the Services, must always realize that our reports will often be studied by military men who will, generally, have no great competence in the technical field in which we work. Yet these military men have a great responsibility. They must weigh our work and make momentous decisions which, in the aggregate, will have real effects upon the ability of our country to defend herself. We must make every effort to sell ideas that are good through the medium of the written report. Conversely I might add that the well written report is often useful in destroying a crackpot idea.

IF WE ARE TO reach our goal we must use precise language and we must avoid as much as possible the use of language that is peculiar to some particular scientific field. We must make our language as forceful and as simple as possible.

And as a corollary I would urge that we insist upon conclusions which offer a basis of judgment to the man who is not skilled in the technical field being reported.

I know that professional writers and editors are fully aware of the importance of using precise English and of the importance of clear-cut conclusions. I see many reports in the course of a year and I am not convinced that writers and editors generally remember that the men who must study and analyze reports, and make decisions based upon reports, are not in general experts in the field of work being reported.

ON DEFENSE COMMITTEE

Vice Admiral Earle W. Mills, USN (Rt.), president of the Foster Wheeler Corporation and member of the Technical Manpower Commission of A.F.C.A., is one of 35 business and civic leaders appointed to the 1955-56 National Defense Committee of the Chamber of Commerce of the United States.

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ANNUAL MEETING

(Continued from page 6)

Rear Admiral Nathaniel S. Prime (ret.) was elected first vice president. The Honorable Dan A. Kimball, Secretary of the Navy, was the guest speaker at the annual banquet. Music was furnished by the Blue Jacket Choir from the Great Lakes Training Station. Other speakers at the meeting included Maj. Gen. E. F. Bullene, who had succeeded General McAuliffe as the Chief Chemical Officer; Brig. General William M. Creasy and Brig. Gen. H. M. Black of the Chemical Corps; Mr. Telford Taylor, Administrator of the Small Defense Plants Administration; and Colonel Ragnar Johnson, Commandant of the Chemical Corps School. The Chicago meeting included, it is believed for the first time, a special program for the women members of the Association and the wives of members attending. This consisted of a fashion show, luncheon, and visits to shops.

1953: Meeting at Waldorf Astoria in New York City; Talks on Technical Manpower, Chemical Industry and Atomic Energy.

THE 1953 MEETING of the Association was held at the Waldorf Astoria in New York City on May 20-21. Both Colonel Munchmeyer, president, and Admiral Prime, first vice president, were re-elected. The morning session on May 21 was featured by talks on technical manpower by Dr. Walter E. Lawson, Chairman of the A.F.C.A. Technical Manpower Commission; Vice Admiral Earle W. Mills (ret.); Colonel Kuhn; and Colonel Oscar C. Maier, USAF (ret.), Director, Research and Development of the Pullman-Standard Car Manufacturing Company. At the afternoon session speakers included General Bullene; Mr. Howard R. Huston, vice president, American Cyanamid Company; Dr. R. E. Gibson of the Applied Physics Laboratory of Johns Hopkins University; and Maj. Gen. William N. Porter (ret.), Chairman of the Board of the Chemical Construction Company and president of the New York Chapter A.F.C.A. At the banquet the speaker was Mr. Harry A. Winne, vice president of General Electric Company, who spoke on the industrial application of atomic energy.

1954: Meeting Held in Nation's Capital; Elaborate Exhibits Mark Outstanding Gathering with Air Force as Host Service.

ONE OF THE MOST elaborately prepared annual meetings of the Association was the 1954 gathering at the Hotel Shoreham in Washington, D. C., May 16 and 17. The U. S. Air Force, in the role of host service, provided an extensive program including a briefing at the Pentagon on the current military situation and a demonstration and luncheon at Andrews Air Force Base. A.F.C.A.'s Washington Chapter assisted National Headquarters in the arrangements. The speaker at the annual banquet was General Curtis E. LeMay, Commander of the Strategic Air Command, and music was furnished by the Air Force Ceremonial Band. Special features of this meeting were the elaborate exhibits of equipment and activities by the Air Force, the Atomic Energy Commission, the Chemical Corps of the Army, the American Chemical Society and also by a number of industrial concerns which presented displays of their work pertaining to National Defense. President Eisenhower, having occasion to go to the hotel for another meeting, honored the A.F.C.A. by a visit to the exhibit area in the hotel corridors.

The Friday afternoon program consisted of addresses on National Defense subjects by Major Gen. William M. Creasy, newly appointed Chief Chemical Officer; Major Gen. Morris R. Nelson, U. S. Air Force; Rear Admiral W. G. Schindler, U. S. Navy; and the Honorable Val Peterson, Federal Civil Defense Administrator.

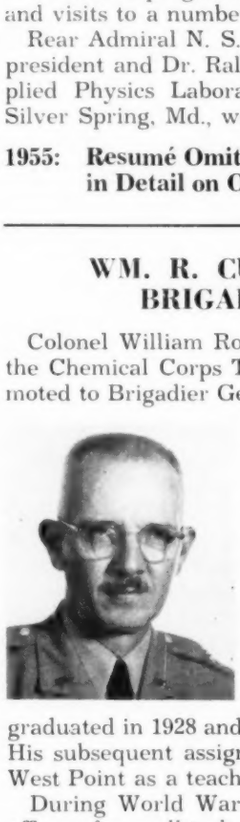
The ladies' program included a visit to the White House and visits to a number of the foreign embassies.

Rear Admiral N. S. Prime, U.S.N. (ret.), was elected president and Dr. Ralph E. Gibson, Director of the Applied Physics Laboratory, Johns Hopkins University, Silver Spring, Md., was elected first vice president.

1955: Resumé Omitted Since Meeting Was Reported in Detail on Our Last Issue.

WM. R. CURRIE IS MADE A BRIGADIER GENERAL

Colonel William Ross Currie, Commanding Officer of the Chemical Corps Training Command, has been promoted to Brigadier General. His nomination to this temporary rank was confirmed by the Senate on July 22.



General Currie was born on July 6, 1906, at Fort Leavenworth, Kansas, the son of the late Brigadier General Dennis Hadley Currie. He attended school at various Army posts and cities in the United States and Hawaii, and in 1924 won a presidential appointment to the United States Military Academy, West Point, New York. He was graduated in 1928 and was commissioned in the Infantry. His subsequent assignments include a 4½-year tour at West Point as a teacher of mathematics.

During World War II Gen. Currie became executive officer of a small task force which was sent, after a year's training, to Liberia. In 1944 he assumed command of the force on the departure of the commanding general.

In 1945 Gen. Currie returned to the United States and received refresher training at The Infantry School. He attended the University of Chicago from 1946 to 1948, doing graduate work in physics and mathematics. He was then ordered to Army Chemical Center, Maryland, where he had varied assignments in connection with the Chemical Corps research and development program. He transferred to the Chemical Corps on March 22, 1950.

General Currie has been awarded the Legion of Merit; Commander of the Star of Africa (Liberia); Order of the British Empire, and the Croix de Guerre, with palm (1942) (Belgium).

DR. WILLIAM J. HALE

Dr. William J. Hale, 79, outstanding organic chemist and research consultant of the Dow Chemical Company, died in Midland, Michigan, on August 8, 1955, after a brief illness.

Dr. Hale, who was the author of numerous books on chemical subjects, was perhaps best known as the father of "chemurgy" which he defined as "the direction of nature's life agencies to the production of chemicals for industry." He was a pioneer in the development of chlorophyl for use in food products.

Dr. Hale's wife, who died in 1918, was Helen Dow, daughter of Herbert H. Dow, the founder of the Dow Chemical Company.

THE REPORT ON CML. CORPS BY THE MILLER COMMITTEE

Changes in the organizational structure of the Chemical Corps of the Army were recommended in a report submitted in August by the Ad Hoc Advisory Committee on the Chemical Corps Mission appointed by the Chief Chemical Officer, Major General William M. Creasy.

The Committee was headed by Mr. Otto N. Miller, vice president of the Standard Oil Company of California, as chairman, and was known as the Miller Committee. (See July-August issue.)

As the Journal went to press no announcement had been made in regard to approval of the report which is understood has been referred for consideration by higher authority. In addressing the annual meeting of A.F.C.A., in Cleveland last June, General Creasy made reference to this Committee, expressed confidence that it would submit sound recommendations, and added: "And I intend to follow out those recommendations insofar as possible, so long as they mean that we will have a stronger and more efficient operational organization for the Corps."

The Committee prefaced its recommendations with comment upon the importance and mission of the Chemical Corps, stating in part as follows: "The Chemical Corps must be a seed bed of new ideas for agents and weapons, and must provide the climate best adapted to their development and growth. Uninhibited speculation covering all possible agents and methods for converting them to effective weapons, and for developing defense against such weapons, must be encouraged in and by the Corps. . . ." Highlights of the recommended organizational structure follow:

1. Top Management—To consist of the Chief Chemical Officer, Deputy Chief Chemical Officer, and Deputy Chief Chemical Officer for Scientific Activities; the latter to be a civilian in continuance of the present practice.

2. The Command Structure—To consist of a Research and Development Command and an Engineering Command as separate organizations replacing the present Research and Engineering Command; and a Materiel Command. The present Training Command would be discontinued.

a. *Research and Development Command.* The commander and certain key personnel of this command to be stationed in Washington in close contact with the Chief Chemical Officer, size of the present R&D Staff in the Chief's office to be reduced. Another major change: placement of the responsibilities for biological warfare activities in the R&D Command, eliminating the position of Assistant Chief Chemical Officer for BW.

b. *Engineering Command.* Establishment of a separate Engineering Command to encompass generally all of the engineering activities of the Corps, including those of the present Engineering Agency at Army Chemical Center.

c. *Materiel Command.* The functions of this command to cover procurement, production, supply, and industrial mobilization planning; the command headquarters to be moved from Baltimore to the Army Chemical Center where it would take over the post administration responsibilities, relieving the R&D organization of those functions. Materiel Division in Chief's office to be eliminated but provision made for a Requirements and Production Planning Office there.

3. Planning and Doctrine. The Committee recommended the assignment to the Chief of an Assistant Chief Chemical Officer in charge of Planning and Doctrine and dissolution of the present Plans, Training and Intelligence Division in the Chief's office. The Assistant for Planning and Doctrine would supervise four functional groups, viz.:

a. Military plans group for long range studies.

b. Group in charge of preparing and keeping up to date comprehensive documents pertaining to chemical, biological, and radiological warfare.

c. Group consisting of officers of high rank for liaison with other agencies of the Army, Navy, Air Force, and other governmental departments.

d. Group for current military planning and to include the Chemical Corps Board.

4. Intelligence, and Career Planning. Under this proposed reorganization separate agencies for Intelligence and for Career Planning, reporting directly to the Chief Chemical Officer, would be provided.

5. Training—The Committee recommended as a matter of general policy the transfer of military training responsibilities of the Corps to the Continental Army Command with the exception of the operation of the Chemical Corps School. It recommended that the Chief Chemical Officer continue to train such chemical TOE units as are assigned to him but stated that Chemical Corps units assigned to the Army in the field in support of ground combat troops should be trained in conjunction with combat troops by the Continental Army Command.

6. General. The Committee in its report also emphasized, for commissioned officers, advanced training to and beyond the doctorate level, with provisions for high rank for well-trained professionals. For civilian personnel the Committee emphasized freer interchange of personnel with university groups, more rapid advancement and assignment of super grades to research installations.

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ENGINEERING

(Continued from page 12)

The M173A1 fuze is designed to trigger the M23A1 igniter used to activate the M116A1 fire bomb. In operation, when the fire bomb is dropped from the carrier plane, the arming wire which is attached to the bomb hangar is withdrawn from the fuze. This withdrawal of the pin permits rotation of the anemometer type head by the airstream. The anemometer head is attached to a threaded shaft which constitutes the safety pin. Rotation of the anemometer type head unscrews the safety pin, both of which are released into the air stream, and thus arming the fuze. On impact of the bomb with the target, the fuze, which contains a burster charge, fragments the white phosphorus (WP) filled igniter, the WP in turn ignites the thickened gasoline filling of the bomb.

The cost savings were effected by changing from the small threaded head shown in Figure 5, which was machined from round brass bar stock, to the large threaded zinc alloy die cast head shown in Figure 6. Use of the large diameter head eliminated the need for the standard steel bushing shown in Figure 5, which was required to adapt the M173 fuze to the M23A1 igniter, and dispensed with several machining operations as well as the assembling operation for the adapter. The improved fuze was redesignated the M173A1 fuze.

Conclusion

The importance of designing for economical mass-producibility in order to conserve dollars and natural resources can be readily seen. This is true especially when considered in light of the simple fact that only one penny saved per unit amounts to $10,000 per million units; that only one minute of labor saved per unit amounts to 16,666 hours, 2,083 days, 416 weeks, or, eight man-years per million units.

Even at the minimum rate of 75c per hour for unskilled labor, although it can very seldom be used since most operations require skilled or semi-skilled labor, the saving amounts to $12,500. Use of skilled labor at approximately $2.00 per hour would boost this figure to approximately $33,332.

Only one ounce of material saved per unit amounts to 62,500 pounds, or 31.25 tons per million units. With a commonly used material such as fabricated steel, for example, two-inch diameter cold rolled bar stock at the current price of approximately $160 per ton, the saving amounts to $5,000 per million units.

Because of the very grave concern for the necessity to engineer military items for economy of manufacture and in order to reemphasize this objective, the author wishes to point out that most military items are produced in quantities of millions. It can be readily seen, therefore, that reengineering an item to save only one penny per unit saves $200,000 in the production of twenty million units. Thus, when consideration is given to the vast number of items in the military supply system, it is seen that the potential saving to the taxpayers by engineering for economical manufacture is astounding.

In the pursuit of its principal mission, which is engineering for economical mass-producibility insofar as product design is concerned, the Chemical Corps Engineering Agency (based on past procurement during the Korea conflict) has already achieved enormous savings in materials and labor.

Acknowledgment

The assistance of the following Chemical Corps Engineering Agency Products Division personnel is gratefully acknowledged for supplying the indicated item information used in the examples of savings accomplished:

Mr. Warren R. Miller, Protective Branch, Project Engineer on the Waterproofing Bag, M1.

Mr. Abraham Rednor, Munitions Branch Project Engineer on the Fire Bomb, M116A1 and the Igniter Fuze M173A1.

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CHEMICAL CORPS EMPLOYEE IS ELECTED HEAD OF NFFE

Mr. Michael E. Markwood, Deputy Comptroller for the Chemical Corps Materiel Command since 1952, recently was elected president of the National Federation of Federal Employees, succeeding Mr. Luther Steward who has retired after 37 years as leader of that organization. Mr. Markwood planned to relinquish his position with the Chemical Corps about the middle of August.

Born on September 27, 1914, Mr. Markwood attended school in Pennsylvania and the District of Columbia and entered the Federal service in 1934. In 1946 he joined the staff of NFFE as a National Representative and two years later returned to government work. He resides at 159 Regester Avenue, Baltimore, Md.

Mr. Markwood and Mr. Henry G. Nolda, newly elected secretary-treasurer of the Federation, made a joint statement following their election in praise of the work of their predecessors, Mr. Steward and Miss Gertrude M. McNally.

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PRODUCTION AND MEASUREMENT OF UNIFORM FREE-FALLING DROPS

By Abraham Koblin

Chief, Chemical Test Branch
Test Division
Chemical Corps Chemical and Radiological Laboratories
Army Chemical Center, Maryland

There was a requirement at Army Chemical Center to determine the actual size of free-falling liquid droplets by measuring the stains produced on a card surface. To accomplish this, it was necessary to determine the ratio of the diameter of the stain each droplet produced to the actual drop diameter, and to utilize an apparatus which would produce uniform free-falling drops.

Numerous methods for producing uniform drops have been described in the literature (1), (2), (3), (4), and have been found to be generally quite satisfactory. However, due to the high toxicity of some of these materials tested, it was desired to handle only small volumes of liquid (5 to 10 ml.) at any given time. Consequently, the methods described in the literature could not be adopted conveniently in this work.

As a result an apparatus was designed that produces relatively large uniform free-falling drops in quantity and required only a small volume of liquid for dispersion.

Description of the Spinning Tip Apparatus

The apparatus consists of a small Erlenmeyer flask fabricated from Pyrex glass and having a closed tube extending downward from the center of the flask. It has two tubes extending out of the sides 180° apart and approximately 25° from the horizontal. One of the tubes is closed-tipped, while the other is adapted to contain a small capillary tube. The top of the apparatus is closed by a standard-taper stopper having a 1-mm. hole at its tip to allow air to enter as the liquid is being dispersed (Figure 1).

The capillaries were prepared by drawing out 2-mm. heavy-wall glass tubing. A uniform section was selected and sized so that approximately 4 to 5 mm. extended beyond the opening of the arm when placed into the body of the apparatus. The capillary was cemented in place with DeKhotinsky compound (Figure 2). The capillary tip was ground to an angle of approximately 45° in order to provide a tapered surface for emission of droplets. Additional capillaries of different internal diameters were prepared in the same manner to give various drop size ranges.

Preparation of Dispersoid

A dye tracer was used in this work so that the droplet stains could be seen readily and measured on the collecting card surface. The dispersoid was prepared by adding sufficient quantity of dye to the liquid being investigated to make a 5% solution. Care was taken to see that all the dye dissolved. An aliquot of known weight was added to a 100-ml. volumetric flask and made up to volume with a suitable solvent. Convenient dilutions of this stock solution were prepared and a calibration curve was established using a Klett-Summerson colorimeter by plotting on coordinate paper the net colorimeter scale read-

Spinning Tip Apparatus

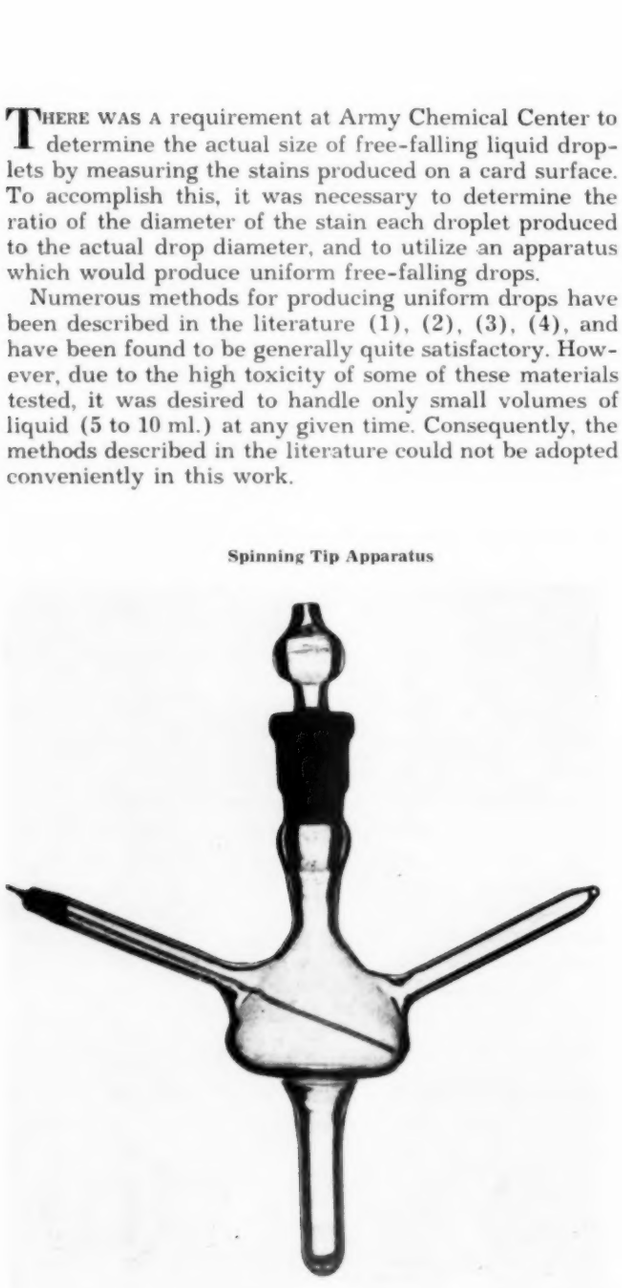

Fig. 1

Drop-Producing Capillary

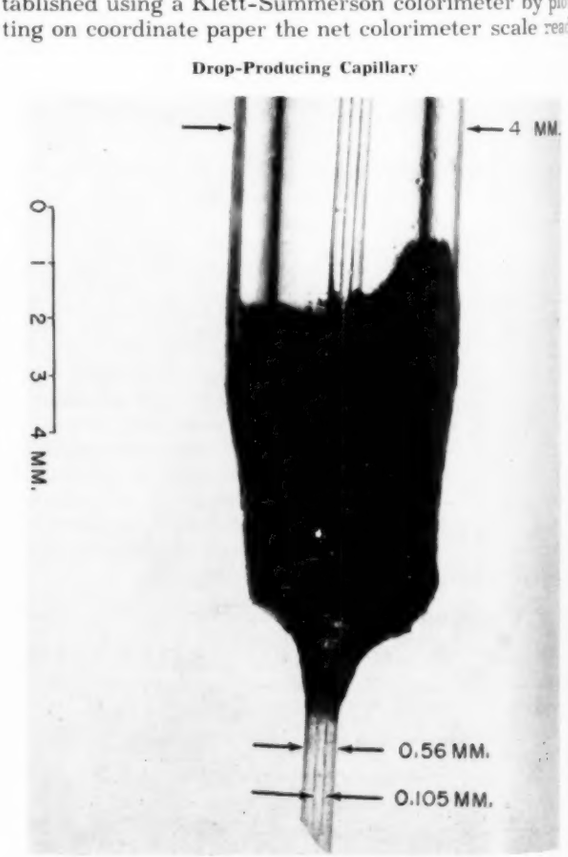

Fig. 2

ings versus the corresponding weight of dispersoid per milliliter of solution.

Sampling Card

The sampling card used to collect the droplets measured to 10 by 10 in. and was approximately ¼ in. thick. The surface was smooth, highly absorbent, and similar in texture to No. 1 Whatman filter paper.

Operation of Spinning Tip

The spinning tip was prepared for operation by inserting the extended tube into the chuck of a variable high-speed motor (Figure 3). The apparatus was then placed in a dispersing chamber which was provided with a cover or a ventilating system. Sufficient space was provided to permit the drops to fall freely as they were being produced. A sampling card was positioned on the floor of the chamber so that the drops would be falling almost vertically before they contacted the card surface. Three glass microscope slides 1 by 3 in. were then spaced in a row in the fall-out area on the sampling card.

Approximately 10 ml. of dyed dispersoid was introduced into the spinning tip apparatus through the opening on top.

A shield, provided with a narrow vertical slit and shutter, was aligned between the spinning tip and the sampling card. This shield was used to prevent contaminating the sampling card and slides with undesirable drops produced as the motor approached constant speed.

The motor was then allowed to attain the desired speed, and the shutter was opened. When it appeared that sufficient drops were collected on the slides and card, the motor was stopped and the glass slides were removed immediately. The number of drops collected on each slide was noted, and each slide was then washed thoroughly with a minimum known volume of solvent. The color was then read in the Klett-Summerson colorimeter, and the quantity of dispersoid collected on each slide was determined from the calibration curve. This total quantity of dispersoid found on each slide was divided by the number of drops on each slide, giving an average weight per drop. The diameter of the drop was calculated from the formula:

$$D = \sqrt[3]{\frac{6M}{\pi\delta}} \quad \text{where} \quad \begin{array}{l} D = \text{diameter} \\ \delta = \text{density of dispersoid} \\ M = \text{weight per drop} \end{array}$$

The stains on the sampling card were measured under low magnification and the average diameter was calculated. This procedure was repeated with various motor speeds. The stain diameters were plotted against actual diameters on logarithmic graph paper giving a straight-line relationship.

During the developing stages, water dyed with FD&C No. 1 Green (FD&C No. 1 Green is the monosodium salt of 4- [4- (N-ethyl-p-sulfobenzylamino) diphenylmethylene] - [1-(N-ethyl-N-p-sulfoniumbenzyl)-$\Delta^{2,5}$- cyclohexadienimine]) was dispersed as described above, before attempting to use a toxic material.

Stain sizes were obtained for many trials and correlated with actual drop size (Table 1). A correlation was also made between motor speeds and stain size (Table 2).

When the data give in Table 2 are plotted on logarithmic graph paper, it will be seen that the drop size is inversely proportional to the speed of the motor. In speeds greater than 3300 r.p.m. the drops were too small to collect by fall-out upon the sampling card. Therefore it cannot be ascertained, at this time, whether this linear relationship holds for higher speeds.

This apparatus produced extremely uniform drops whose stain diameters varied less than 10%. Satellites which could introduce an unknown error and account for a nonuniformity in droplet information could not be observed.

Spinning Tip Apparatus Mounted in Chuck of Variable High-Speed Motor

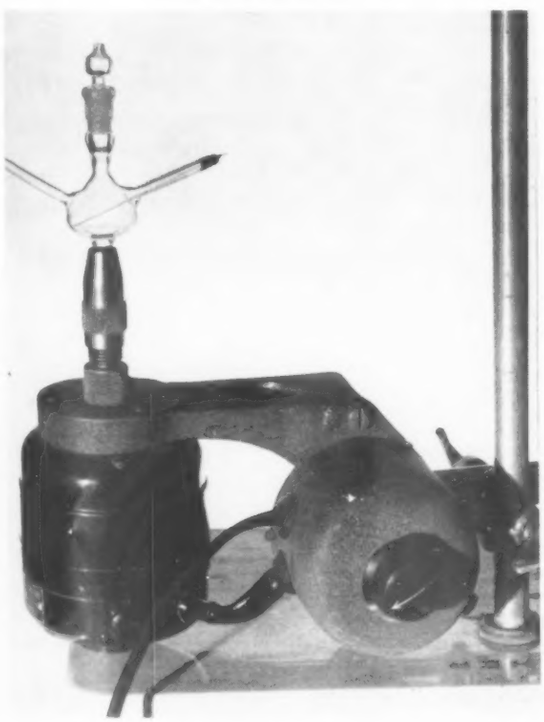

Fig. 3

TABLE 1

Comparison Between Actual Diameter and Stain Diameter

Run	*Actual Drop Diameter*	*Stain Diameter*
	mm.	*mm.*
1	0.23	0.26
2	0.24	0.26
3	0.37	0.52
4	0.40	0.60
5	0.65	0.94
6	0.66	0.96
7	0.80	1.60
8	0.84	1.80
9	1.35	2.95
10	1.30	2.70

TABLE 2

Comparison Between Motor Speed and Stain Diameter

Motor Speed	*Stain Size*
r.p.m.	*mm.*
1050	2.96
1580	1.99
2200	1.55
2610	0.96
2900	0.81
3320	0.52

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Mason, L. E., Company, Hyde Park, Mass.
Mathieson Chemical Corporation, Baltimore, Md.
Merck & Company, Inc., Rahway, N.J.
Milwaukee Stamping Co., Milwaukee, Wis.
Mine Safety Appliances Co., Pittsburgh, Pa.
Monarch Aluminum Mfg. Co., Cleveland, Ohio
Monsanto Chemical Company, St. Louis, Mo.
National Fireworks Ordnance Corp., West Hanover, Mass.
Niagara Alkali Company, New York, N.Y.
Niagara Blower Co., New York, N.Y.
Nopco Chemical Co., Inc., Harrison, N.J.
Oldbury Electro-Chemical Co., Niagara Falls, N.Y.
Olin Mathieson Chemical Corp., East Alton, Ill.
Oronite Chemical Company, San Francisco, Calif.
Parsons, Ralph M., Company, The, Los Angeles, Calif.
Pemco Corporation, Baltimore, Md.
Penick, S. B., & Company, New York, N.Y.
Pennsylvania Salt Manufacturing Co., Philadelphia, Pa.
Pfizer, Chas. & Company, Inc., Brooklyn, N.Y.
Philco Corporation, Philadelphia, Pa.
Phillips Petroleum Company, Bartlesville, Okla.
Pittsburgh Coke & Chemical Co., Pittsburgh, Pa.
Rau Fastener Co., New York, N.Y.
Rohm & Haas Company, Philadelphia, Pa.
Rudy Manufacturing Co., Dowagiac, Mich.
Shea Chemical Corp., Jeffersonville, Ind.
Shell Chemical Corp., Denver, Colo.
Shell Development Company, Emeryville, Calif.
Sheller Mfg. Co., Dryden Rubber Div., Chicago, Ill.
Sherwin-Williams Company, The, Cleveland, Ohio
Shwayder Bros., Inc., Denver, Colo.
Standard Oil Company (Indiana), Chicago, Ill.
Stauffer Chemical Company, New York, N.Y.
Stewart-Warner Corporation, Chicago, Ill.
Sun Oil Company, Philadelphia, Pa.
Thomas Industries, Inc., Ft. Atkinson, Wis.
Union Carbide & Carbon Corp., New York, N.Y.
United-Carr Fastener Corp., Cambridge, Mass.
United States Rubber Company, New York, N.Y.
Universal Match Corp., Ferguson, Mo.
Vitro Corporation of America, New York, N.Y.
Vulcan Copper & Supply Co., The, Cincinnati, Ohio
Western Electrochemical Company, Henderson, Nev.
Witco Chemical Company, Chicago, Ill.
Wyandotte Chemicals Corp., Wyandotte, Mich.
Zaremba Company, Buffalo, N.Y.
Zenith Aircraft, Div. of Zenith Plastics Co., Gardena, Calif.

Companies listed in bold face type are Sustaining Members

MISCELLANY—

EXERCISE SAGE BRUSH PROVIDES CBR TRAINING

The tentative schedule for Army training exercises during the fiscal year 1956 includes exercise SAGE BRUSH, a major joint Army-Air Force program designed to provide training under battlefield conditions in the field of atomic, chemical, bacteriological, radiological and electronics warfare.

The Department of Defense announcement states that approximately 110,000 Army and 30,500 Air Force personnel will participate in this exercise, tentatively scheduled to be held in the Camp Polk, Louisiana area during the period November-December 1955. The Army forces scheduled to participate include an Army headquarters, two Corps headquarters, two armored divisions, one infantry division, an armored cavalry regiment, and selected artillery, engineer and logistical support troops.

SILVER STAR TO LT. JOHNSON

Lt. Eugene C. Johnson, Jr., Army Chemical Center (Md.) billeting officer, was recently honored at a retreat parade and awarded the Silver Star. Post Commander Brig. Gen. John R. Burns made the presentation. Lt. Johnson, while serving in the area of the Iron Triangle and Heartbreak Ridge in Korea pulled one of his men from a foxhole in time to save him from the explosion of an enemy grenade which had landed there.

DINNER GIVEN AT ACC IN HONOR OF MISS NAGELL

Notably missing from the Army Chemical Center, Md., these days is the cheerful presence of Miss Rosella R. Nagell. Miss Nagell, who was the administrative assistant in the office of Brig. General John R. Burns, the commanding general, recently retired after 36 years of government service, 35 of them at the Army Chemical Center. She was assigned to the office of the commanding officer in 1931 and was the secretary and administrative assistant to all commanding officers of the post until she retired. A testimonial dinner was held in her honor at the Gunpowder Officers Mess, at which time she was given an engraved silver tray. Miss Nagell's knowledge of events and facts of the old Edgewood Arsenal was known throughout the Corps and made her a "consultant ex-officio" on the history of the Center.

SCHOOL GIVEN STATUETTE BY ITALIAN CHIEF OF STAFF

A statuette of a 19th century artilleryman of the Piedmontese Army, the gift of the Italian Chief of Staff to the Chemical Corps School at Fort McCellan, Ala., was presented recently to Colonel Edwin Van Keuren, at right in picture above, commandant of the School, by Major General Amedea Gabrielle of the Italian Army.

Gen. Gabrielle said that Gen. Georgio Luizzi, Chief of Staff of the Italian Army, who a month previously had visited the United States, wanted to see the Chemical Corps Training Command but was unable to make the trip to Fort McClellan. Before he returned to Italy, he left the statuette with the Italian attaché in Washington, with instructions for its delivery by General Gabrielle.

The statuette is a miniature of a life-size statue at the base of a monument in Turin, Italy, erected in 1861, in honor of King Carlo Alberto, who first started the struggle that was later to lead Italy to full independence and unification.

40,000,000th BIBLE

Post Chaplain (Lieutenant Colonel) Paul E. Winslow at the Army Chemical Center, Md., recently presented to Brigadier General John R. Burns, post commander, the 40,000,000th copy of the Bible given to the Armed Forces by the American Bible Society. Chaplain Winslow is a veteran of more than eight years overseas service during World War II and the Korean conflict.

GEN. SAYRE HONORED

Brigadier General Clifford L. Sayre, Chemical Corps Reserve, whose promotion was announced in the May-June issue of the Journal, was honored at a testimonial dinner sponsored by the 475th Chemical Battalion and the Buffalo Chapter of the A.F.C.A. at the 40 and 8 Club in Buffalo on May 6.

General Sayre, development chemical engineer for Becco Chemical Division, Food Machinery and Chemical Corporation, was presented with a set of general officer's insignia and a gold pen and pencil set at the dinner at which Mr. R. Lindley Murray, president of the Hooker Electrochemical Company, was toastmaster.

General Sayre was elected second vice president and chairman of the Finance Committee of A.F.C.A. at the annual meeting in Cleveland last June.

CHEMICAL CORPS ATHLETES TAKE FOUR EVENTS

Chemical Corps athletes swept to four Second Army championships at recent meetings held throughout the Army area. Capt. Marion E. Carlson, WAC of the Army Chemical Center, won the women's golf championship at Fort Meade. Master specialist Emil W. Johnson, Camp Detrick, Md., took the tennis tournament's Senior division, while Pfc. John M. Donaldson of Detrick broke the Second Army discus record at Fort Lee. Amby Banks led the Army Chemical Center swimming team to its second consecutive title at Valley Forge Army Hospital with a total score of 81 points over second-place Fort Knox's 73.

Capt. Carlson, women's champion at the Army Chemical Center, was medalist of the Meade tourney. She defeated Capt. Mahoney of Valley Forge Army Hospital 2 and 1 in the final match. She is a native of Mississippi, where she earned a degree in psychology at Millsap College.

Banks, former coach of the Oak Ridge Atomic City Athletic Club, won two events at Valley Forge—the 100-yard butterfly and the 400-yard individual medley.

Pfc. Donaldson, a former university professor and holder of four college degrees, established a new Second Army record of 157 feet, 2 inches, for the discus. Donaldson is former National AAU discus champ and volleyball All-American.

Specialist Johnson won the Senior Division tennis tourney with a victory over Col. Butler of Second Army in the final match. Johnson is captain of the Camp Detrick tennis team. He has a total of 24 years active and reserve Army service and holds degrees in chemistry and bacteriology from the University of Kentucky.

STATISTICS CONSULTANT

Dr. Acheson J. Duncan, associate professor of statistics at the Johns Hopkins University, has been appointed consultant in statistics to the Chemical Corps Engineering Agency at Army Chemical Center, Edgewood, Md.

DEFENSE RESERVE AWARD

The Defense Department has announced the Defense Reserve Award to be presented to employers of military reservists on the basis of favorable policies and activities with respect to military reservists and the reserve program.

The award consists of a bronze plaque with a citation certificate and display pennant and may be given an employer, company or business, regardless of the number of reservists employed. Points to be considered in making the award are policies as to leave, in addition to annual leave, for reserve training or emergency duty, with full pay or difference between military and company pay; hiring, promotion, or transfer of reservists without discrimination; and assistance to reservists in making scheduled inactive duty drills and tours of active duty for training.

Actions to support such policies, for instance provision of bulletin boards, meeting rooms, training aids, transportation, company news media, exhibits, and advertising in newspapers and radio programs, etc., are also factors to be considered.

Recommendations for the award are expected to come from the reservists employees to the Secretary of the military departments concerned. They will be reviewed by a committee consisting of Mr. John H. Fanning, Director of Industrial Relations, Office Assistant Secretary of Defense for Manpower and Personnel, as chairman, and representatives from each of the military Services.

ID TAGS TO INDICATE RELIGION

Henceforth the identification tags issued to members of the Armed Forces will spell out the religious preference of the wearer.

The purpose of this, according to an announcement by the Department of Defense, is to assure a chaplain, in an emergency, has a clear knowledge of an individual's faith and can see that appropriate last rites are administered.

The present practice with respect to religion designations on the tags is merely to stamp the tag with the letter "P" for Protestant, "C" for Catholic, "J" for Jewish, "X" for other religions, and "Y" for cases where personnel do not desire any religious preference indicated.

Tags already issued will not be called in but persons now in service who desire to have their faith designated in full may make arrangements for new tags.

MINIATURE WEATHER STATION

The Navy has announced the development of a new aid to mariners—a complete miniature weather station set which can be held in one hand aboard ship so as to record automatically essential weather data in total darkness and under severe weather conditions.

It was designed to supplement standard permanent weather instruments under conditions which make it impractical or dangerous to use them.

The new weather recording set, now undergoing service evaluation tests at sea, weighs about six pounds. Its height is 23 inches.

When held at arm's length for a few moments the sensing elements of the set quickly position individual dials to measure surface atmospheric pressure, temperature, relative humidity, wind speed and direction. A lever locks all readings in place for subsequent noting and recording in a sheltered area.

GREAT LAKES CHANNELS

The Secretary of the Army has transmitted to Congress a report for the House and Senate Committees on Public Works, recommending that the Corps of Engineers be authorized to deepen the channels connecting the Great Lakes in order to meet the increasing demands of commercial navigation.

The report stated that the deeper channels would permit use of larger vessels, at a savings estimated at $10,000,000 annually, in shipments of iron ore, stone, grain, and other commodities over the next half century.

The report also says that the project would make possible the general expansion of the Great Lakes commerce and, in addition, sizable benefits would accrue with the completion of the St. Lawrence Seaway. (A discussion of the St. Lawrence Seaway project, with particular respect to its influence on chemical industry development, was contained in the May-June issue of the JOURNAL).

CONTRACT APPEALS PROCEDURE

In line with suggestions made by a Task Force of the Hoover Commission on Organization of the Executive Branch of the Government an amendment has been made to the Rules of the Armed Services Board of Contract Appeals.

An announcement concerning this action, made by Mr. Roswell M. Austin, president of the Board, states that the amended Rules provide a definite procedure to be followed by both an appealing contractor and the Government in the processing of appeals before the Board.

It is stated that the new Rules offer the appellant adequate guides on what is required, stated in simple language, while placing no greater burden on either the appealing contractor or the Government.

The appealing contractor must file his complaint within 30 days after his notice of appeal has been forwarded to the Board. Likewise, Government counsel is required to file an answer within 60 days following receipt of the contractor's complaint.

It is expected that the new provision will result in simplification and shortening of the hearings.

Copies of the revised Rules are obtainable from the Recorder of the Board, Mr. William Lyons, Room 3C743, The Pentagon, Washington 25, D.C.

NEW TYPE OF LOCOMOTIVE

A 48-ton experimental locomotive, provided with diesel-mechanical power rather than the generally known diesel-electrical power type, was recently accepted by the Department of the Army.

Railroads in this country generally use the diesel-electrical type unit which employs an engine-driven generator and electric motors mounted on axles to transmit the engine-developed power direct to the driving unit.

In contrast, the new diesel-mechanical locomotive, powered by a single engine, uses a torque converter to transmit engine power down to the wheels. The new type of locomotive is designed to fill the Army's requirement for a locomotive using a minimum of critical materials. It is also expected to result in simplified maintenance and operation.

PLASTIC BARGE

U.S. Army Photo

Designed to meet a requirement for a flat-bottomed, self-propelled craft for use on very shallow inland waterways overseas, a new plastic vessel weighing only 10.2 tons and which can transport five tons of dry cargo with a draft of only 21 inches when loaded, and which has a maximum cargo capacity of 10 tons in deeper water has been developed and built for the Army Transportation Corps. The 50-foot craft is designed so that it can be shipped in sections either by air, rail or truck, and easily assembled in the water. It is not expected to require extensive maintenance.

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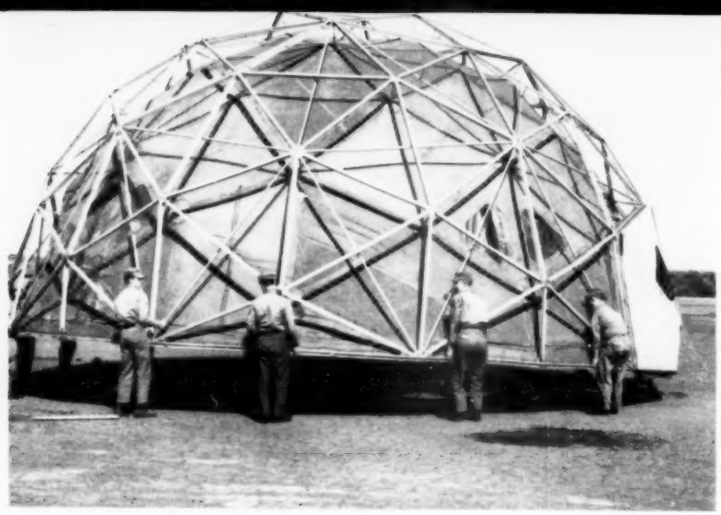
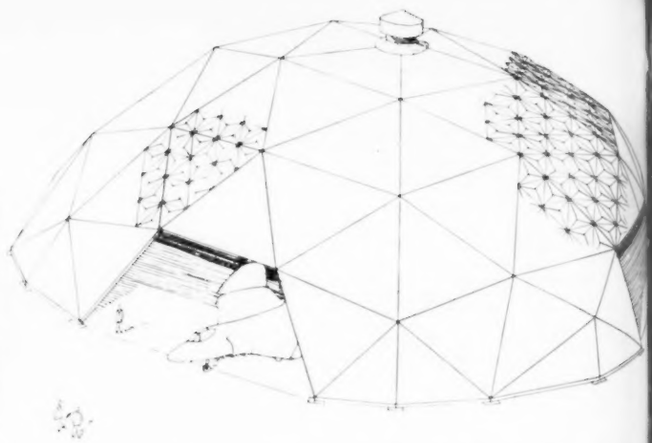


36-foot hemisphere prototype shelter to be issued as replacement for tents for Marine Aviation. Dept. of Defense Photo (Marine Corps).



Sketch of 117-foot six-plane aircraft hangar. After conclusive study it was found that a one-third sphere offered definite advantages for this size shelter. Dept. of Defense Photo (Marine Corps).

MOBILE IGLOOS FOR MARINE CORPS

Interesting applications of the chemistry of metals and fabrics are seen in the development and adoption for Marine Corps use of a new type of light-weight field shelter for troops or equipment, replacing heavy canvas tentage.

The new shelter is referred to as an igloo, presumably because its dome-like shape is similar to that of the Eskimo igloo. A recent Department of Defense news release refers to the shelter as a Geodesic dome designed by Buckminister Fuller and states it is described as the first basic improvement in mobile shelters in the past 2600 years.

The igloo is a self-supporting structural frame of strong lightweight metal forming the dome from which weatherproof insulated material of neoprene-coated synthetic fabric is suspended to form the sheltered inclosure.

The Marine Corps igloos, the Department states, can be man-carried completely erected or may be lifted by helicopter. They have been adopted for use by Marine Aviation and are under evaluation for possible adoption and use by ground forces. The domes come in four sizes with diameters of 36 feet, 42 feet, 55 feet, and 117 feet. The two larger domes are designed for use as aircraft hangars.

Compared to former means, it is stated that these shelters, while providing increased utility and efficiency for Marine Aviation, require only three percent of the weight, six percent of the packaged volume, 14 percent of the former cost and less than one percent of erection manhours. These savings are reflected in the shipping required to move Marines to a combat area, and the manpower that normally must be diverted from fighting to housekeeping duties. All of these factors would make for a tremendous saving in cost where a large overseas movement were involved. In that connection the Department's release states, "The movement of a single Marine Aircraft Wing equipped with the new Geodesic domes to an advance base overseas would amount, it is estimated, to a $15,000,000 saving over the present system."

U. S. S. FORRESTAL

USS FORRESTAL being removed from drydock.—U. S. Navy Photo.

Ceremonies for commissioning the USS FORRESTAL, world's largest warship and first of a new class of attack aircraft carriers, are scheduled to take place at 2:00 P.M., on October 1, 1955, at the Norfolk Navy Shipyard, Portsmouth, Virginia, according to a Navy announcement.

The commissioning ceremonies, which will follow a series of acceptance trials, will climax more than three years of construction work on the new carrier. Nearly 60,000 tons of metal have gone into the construction of the FORRESTAL. Her width of 250 feet is enough to hold the liners United States and America side by side. The ship will have a crew of 3,500 and will be under the command of Captain Roy L. Johnson, USN, of Falls Church, Virginia.

After commissioning, the FORRESTAL will remain at the naval shipyard for approximately 60 days for outfitting and then will join the Atlantic Fleet for shakedown cruise training.

Three sister ships are presently under construction. They are the SARATOGA, RANGER, and INDEPENDENCE.